E. C. CASE
UNIVERSITY OF MICHIGAN
ANN ARBOR, MICH. U. S. A.

Volume 7 MARCH, 1933 Number 1

JOURNAL OF PALEONTOLOGY

A Publication of the Society of Economic Paleontologists and Mineralogists,
a Division of
The American Association of Petroleum Geologists

CONTENTS

Micropaleontology of the Pennsylvanian Johns Valley Shale of the Ouachita Mountains, Oklahoma, and its Relationship to the Mississippian Caney Shale — *Bruce H. Harlton* 3

The Gastropods of the St. Louis, Missouri, Pennsylvanian Outlier: V. The Trocho-Turbinidae — *J. Brookes Knight* 30

Ostracodes of the Upper Pennsylvanian and the Lower Permian Strata of Kansas: I. The Aparchitidae, Beyrichiidae, Glyptopleuridae, Kloedenellidae, Kirkbyidae, and Youngiellidae — *Betty Kellett* 59

PALEONTOLOGICAL NOTES

Typical Form and Range of *Mesolobus mesolobus* — *J. Marvin Weller and Rex McGehee* 109

Some Texas Localities of *Orbitolina walnutensis* Carsey — *S. A. Lynch* 110

Microcheilinella, a New Name for the Ostracode Genus *Microcheilus* — *H. L. Geis* 112

Cytheridea brightseatensis Berry, a New Name for *C. truncata* Berry — *Willard Berry* 112

REVIEWS AND NEW PUBLICATIONS 113

SOCIETY RECORDS AND ACTIVITIES

Members of the Society of Economic Paleontologists and Mineralogists 114

JOURNAL of PALEONTOLOGY

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The Journal of Paleontology is published quarterly by the Society of Economic Paleontologists and Mineralogists, a division of The American Association of Petroleum Geologists. Numbers are issued in March, June, September and December.

The subscription price of the Journal of Paleontology is $6.00 per year prepaid to addresses in the United States, Mexico, Cuba, Porto Rico, Panama Canal Zone, Republic of Panama, Dominican Republic, El Salvador, Bolivia, Colombia, Honduras, Nicaragua, Peru, Hawaiian Islands, Philippine Islands, Guam, Samoan Islands.

Single numbers, $2.00 each.

Postage is charged extra: For Canada, 20 cents on annual subscriptions (total $6.20), and for all other countries in the Postal Union, 40 cents on annual subscriptions (total $6.40).

Claims for non-receipt of preceding numbers of the Journal must be sent to the Secretary-Treasurer within three months of the date of publication in order to be filled gratis.

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Published at Menasha, Wisconsin

Entered as second-class matter at the Post Office at Fort Worth, Texas, under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized March 9, 1923.

GEORGE BANTA PUBLISHING COMPANY, MENASHA, WIS.

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VOLUME 7 | MARCH, 1933 | NUMBER 1

CONTENTS

PAGE

Micropaleontology of the Pennsylvanian Johns Valley Shale of the Ouachita Mountains, Oklahoma, and its Relationship to the Mississippian Caney Shale . . . . . *Bruce H. Harlton* 3

The Gastropods of the St. Louis, Missouri, Pennsylvanian Outlier: V. The Trocho-Turbinidae . . . . . *J. Brookes Knight* 30

Ostracodes of the Upper Pennsylvanian and the Lower Permian Strata of Kansas: I. The Aparchitidae, Beyrichiidae, Glyptopleuridae, Kloedenellidae, Kirkbyidae, and Youngiellidae . *Betty Kellett* 59

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Typical Form and Range of *Mesolobus mesolobus* . . . . . *J. Marvin Weller and Rex McGehee* 109

Some Texas Localities of *Orbitolina walnutensis* Carsey. . . . . *S. A. Lynch* 110

Microcheilinella, a New Name for the Ostracode Genus *Microcheilus* . . . . . *H. L. Geis* 112

Cytheridea brightseatensis Berry, a New Name for *C. truncata* Berry . . . . . *Willard Berry* 112

REVIEWS AND NEW PUBLICATIONS 113

SOCIETY RECORDS AND ACTIVITIES

Members of the Society of Economic Paleontologists and Mineralogists 114

JOURNAL OF PALEONTOLOGY, VOL. 7, NO. 1, PP. 3–29, PLS. 1–7, MARCH, 1933

MICROPALEONTOLOGY OF THE PENNSYLVANIAN JOHNS VALLEY SHALE OF THE OUACHITA MOUNTAINS, OKLAHOMA, AND ITS RELATIONSHIP TO THE MISSISSIPPIAN CANEY SHALE

BRUCE H. HARLTON[1]
Tulsa, Oklahoma

ABSTRACT

The Johns Valley shale of Pennsylvanian age is characterized by an abundance of nepionic cephalopoda, gastropoda, and brachiopoda, bryozoa, ostracoda, conodonts, and formaminifera. The formation is correlated with the lower part of the Pottsville group. The Caney shale, as restricted by Ulrich, consists of concretionary black shale carrying a typical Mississippian fauna.

This paper is published in two parts. The first part will describe the calcareous algae, foraminifera, conodonts, bryozoa and ostracoda. The second part will describe the gastropoda, pelecypoda, brachiopoda and cephalopoda. Also a fossil chart will be given showing the ranges of the fossils in other correlative areas.

INTRODUCTION

The type locality of the Johns Valley shale of the Ouachita Mountains, is situated in Johns Valley Twps. 1 N. to 1 S., R. 16 E., Pushmataha County, Oklahoma. This is also the type locality of the Caney shale, which name is now restricted to black shale of Mississippian age occurring elsewhere. The areal distribution of the Johns Valley shale in the mountains is in the form of a crescent, the eastern part of which lies north of the Windingstair fault.

At the type locality the shale occupies the floor of Johns Valley and is surrounded by high sandstone hills. This valley is located near the summit of the Ouachita Mountains peneplain in the Tuskahoma syncline, named by J. A. Taff. The formation was named and its paleontology described by E. O. Ulrich.[2]

This paper will describe many of the common microscopic fossils of the Johns Valley shale. A study has been made of many hundred surface samples mainly collected by the late Sidney Powers during the past seven years, and by the writer also in company with H. D. Miser in 1931. The shale is correlated with the lower Dornick Hills, lower Atoka and Wapanucka formations of southern Oklahoma, Morrow of the Ozarks, lower Smithwick and Marble Falls of Texas, and undifferentiated Pennsylvanian shales north of Van Horn,

[1] Published by permission of the Amerada Petroleum Corporation, Tulsa, Oklahoma.

[2] Ulrich, E. O. Fossiliferous Boulders in the Ouachita "Caney" Shale and the Age of the Shale Containing Them, *Okla. Geol. Survey*, Bull. 45, 1927.

Texas. The latter samples were sent to the writer by J. Ben Carsey.

Most of the common organisms of the Johns Valley shale are restricted in age to the lower Pottsville group. The presence of a few late Mississippian forms gives extraordinary interest to the fauna, which is otherwise typically early Pennsylvanian. Owing to the distinct and restricted faunal assemblage in the Johns Valley shale which is found also in the Wapanucka formation the writer believes that the group name, Bendian, of Schuchert[3] should be applied. The Jackfork sandstone is correlative with the sandstone member which comprises the upper part of the Springer formation south of the Arbuckle Mountains.

The fauna is especially rich in calcareous algae, foraminifera, conodonts, bryozoa, brachiopoda, gastropoda, cephalopoda, and ostracoda. Calcareous algae are noted to occur locally and are represented by the genus *Paleohyperamum*. The foraminifera reached a remarkable development and are by far the most abundant element of the Johns Valley fauna, occurring in great profusion. They belong to the genera *Hyperammina*, *Hyperamminoides*, *Hippocrepina*, *Reophax*, *Spirillina Cornuspira*, *Ammovertella*, *Endothyra*, *Endothyranella*, *Orobias*, *Nodosinella* and *Paleotextularia*. The first four of these and *Nodosinella* are very abundantly represented by distinct species, that maintain their identity over large areas, and great reliance can be placed upon the association of these species in making correlations.

Tubicular annelids abound, most of the species being solitary. Free swimming forms (conodonts) are represented by detached jaws and toothed plates. They belong to the genera *Distocodus*, *Scolopodus*, *Prioniodus*, *Hindeodella*, *Lonchodus*, *Multidentodus*, *Holmesella*, *Bransonella*, *Polygnathus*, and *Polygnathodella*. Bryozoa abound a great portion of the Johns Valley shale, the genera *Lioclema*, *Fenestella*, *Acanthocladia*, *Rhombopora*, and *Cystodictya* being frequent. The genus *Archimedes* is present, but rare. Of the brachiopoda, some of the common forms are *Chonetes*, *Pugnax*, *Squamularia*, *Dielasma*, *Spirifer*, *Spiriferina*, *Composita*, and *Hustedia*. The pelecypoda belong to the genera *Nucula*, *Leda*, *Nuculopsis*, and *Astartella*. The gastropoda are represented by numerous genera, *Bellerophon*, *Sphaerodoma*, *Meekospira*, *Macrochilina*, *Pleurotomaria*, and *Pseudozygopleura*. Of the cephalopoda, a common form is *Gastrioceras*.

The ostracodes of the Johns Valley sea were abundant both in individuals and species, and some of them that had lived in Chester time still persisted. They belong to the genera *Paraparchites*, *Cornigella*, *Aechminella*, *Mooreina*, *Monoceratina*, *Kirkbya*, *Amphissites*, *Bairdia*, *Bythycypris*, *Healdia*, *Seminolites*, and *Cavellina*.

It is notable that a great number of distinct organisms flourished in the Johns Valley sea with its muddy de-

[3] Schuchert, Charles, *A Textbook of Geology*, part 2, p. 353, rev. ed., 1924, John Wiley and Sons, New York.

posits. In other correlative areas it is observed that most of them flourished as well in a sea forming calcareous deposits.

The most interesting feature of the Johns Valley shale is the occurrence of erratics discordantly imbedded in the shale. Enormous boulders of lower Paleozoic (largely Ordovician) limestones and cherts are found in the lowest 100 feet of shale. Also, calcareous concretions of Mississippian age are found in the shale both where the boulders are present and absent.

The "Arbuckle" or "Mississippian" Caney shale in Johns Valley, with its abundant phosphatic concretions and masses of concretionary limestone with Caney[4] fossils of Mississippian age, such as is found around the Arbuckle Mountains, the writer, like Ulrich, regards as remanie derived and transported in Pennsylvanian time from the "Arbuckle" Caney shale. The concretionary shale, with Mississippian Caney fossils, is identical with the Caney shale south of Ada, as maintained by Miser, but considering the field relationships, the writer believes that it has been transported to its present position. This interpretation is based strictly on paleontologic and stratigraphic evidence. For example, just north of the Baskett house (cen. S½ Sec. 8, T. 1 S., R. 16 E.) in a 60-foot hand-dug well, abundant Pennsylvanian microfossils are found. A short distance north of this locality a 110-foot boulder of Bromide (Black River) is imbedded in a concretionary shale with megascopic "Arbuckle" Caney fossils and the shale extends to within 40 feet of the water well. Stratigraphically this shale appears to overlie the Johns Valley shale. At the north end of this Ordovician boulder locality on the south side of Johns Creek, there is an excellent exposure of concretionary shale and scores of samples were taken which were barren of microfossils. At the same locality a 4-inch auger hole was drilled to about 7 feet, and from a depth of 3 feet to the bottom several Pennsylvanian crinoids, *Polygnathodella*, *Hyperammina* and *Hippocrepina* were found. A short distance upstream from this locality abundant microscopic Pennsylvanian fossils were found in a black shale, lithologically the same as the concretionary shale. At boulder locations 2 and 4 fossils of Pennsylvanian shale are found within a few feet of shale containing megascopic "Arbuckle" Caney fossils.

At boulder localities 3, 5, and 6, abundant Pennsylvanian fossils were found in shale surrounding boulders of Ordovician limestone.

From a paleontological viewpoint, it is evident that the Johns Valley shale comprises only one zone. In it many boulders of lower Paleozoic limestones, cherts and shales occur. The writer believes that the exotic boulders in the Johns Valley shale are remnants of overthrust sheets of limestone masses and that the Caney shale provided a gliding plane for the overriding thrust sheets, and in this

[4] Ulrich uses "Arbuckle" Caney to designate the black shale of Mississippian age in the Arbuckle region.

manner brought Caney shale into Johns Valley. This process was probably accentuated by mudflows and solifluction.

The writer believes also that the Arbuckle section of rocks including the Caney extends eastward from the Arbuckle Mountains under most of the present Ouachita Mountains.

The rocks of the Ouachita Mountains are lithologically unlike those of the Arbuckle Mountains and are believed to have been deposited a considerable distance south of their present position. The overthrusting which created the Ouachita Mountains came from the south and stripped huge masses of limestone from the then-existing mountains of Arbuckle rocks, east of the present Arbuckle Mountains. Remnants of these limestones form the boulders in the Johns Valley shale.

The geologic map of the Ouachitas shows narrow belts in which there are fault blocks of "Caney" shale, Woodford chert, and Wapanucka limestone, north of the Windingstair Mountain fault. The writer suggests that these are exposed strips of the gliding plane. Ordovician, Silurian and Devonian limestone boulders are known in most of these blocks.

The Johns Valley shale, as mentioned before, also crops out in long narrow belts in the Windingstair Mountains having the general configuration of the Ouachita topography. In addition to the known exposures several new areas have been found which were formerly mapped as Stanley.

The Johns Valley shale generally has the same characteristics wherever found, and an early Pennsylvanian age can be ascribed to all of the exposures noted. The exotic boulders occur sporadically through the exposed belts, together with a markedly contorted Mississippian shale resembling the lower Caney, of the Arbuckle area. These contorted beds bear the appearance of having been included in the Johns Valley shale in much the same manner as the exotic boulders. The writer also suggests the possibility of the presence of exotics from the Woodford formation because of spores in certain masses of shale.

In the Arbuckle Mountains area an unconformity at the base of the Johns Valley shale equivalent is normally noted. It is deserving of note that the Johns Valley shales occur in restricted depressions, many of which have been wholly or partially overspread by later strata.

The Jackfork sandstone was probably deposited in a shallow subsiding basin which was marine at first, but afterwards became continental. This later phase is represented by grits and siltstone, including many plant remains.

Taff,[5] Woodworth,[6] Ulrich,[7] Pow-

[5] Taff, J. A., Some Erratic Boulders in Middle Carboniferous Shale in Indian Territory; *Science*, new ser., vol. 21, p. 225. 1905; Ice-borne Boulder Deposits in Mid-Carboniferous Marine Shales; *Science*, new ser., vol. 29, p. 637, 1909; *Geol. Soc. America, Bull.* vol. 20, pp. 701–702, 1910.

[6] Woodworth, J. B., Boulder Beds of the Caney Shale at Talihina Okla., *Geol. Soc. America, Bull.*, vol. 23, pp. 457–462, 1912, *Science*, new ser., vol. 35, p. 319, 1912.

ers,[8] and Miser[9] believe that the exotic boulders in the Johns Valley shale were transported by floating ice. Another suggestion has been made that the boulders were derived from landslips.[10] The hypothesis of overthrust-sheets has been elaborated by Van der Gracht.[11]

SYSTEMATIC DESCRIPTIONS

Division THALLOPHYTA

Family CORALLINACEAE

Subfamily MELOBESIEAE

Genus PALEOHYPERAMUM Harlton, n. gen.

Test elongate, cylindrical, constrictions at irregular intervals; tissue composed of minute cells, transversing the test obliquely to constituting a minor axis, rather irregular in arrangement; the transverse sections show a highly irregular network. Genoholotype, *Paleohyperamum pottsvillensis*, Harlton, new species.

PALEOHYPERAMUM POTTSVILLENSIS Harlton, n. sp.

Plate 1, figures 7*a–c*

Test elongate, cylindrical, usually of rather uniform diameter throughout, sometimes tapering; surface marked by irregular constrictions; wall calcareous, smooth, usually a reticulated network visible on exterior. Length up to 3 mm. Length of holotype, 1.23 mm.; diameter, 0.44 mm.

This species is usually compressed, and may easily be mistaken for *Hyperammina elongata clavatula* (Howchin), but when wet most specimens show a faint reticulated network.

Johns Valley shale, southern Oklahoma, loc. P-69. Holotype, U. S. National Museum No. 85500. Longitudinal sections No. 85500.

PALEOHYPERAMUM sp.

Plate 1, figure 8

Test elongate, straight or gently curved, surface smooth, marked at irregular constrictions. Length, 1.04 mm.; diameter, 0.32 mm. Only two specimens were found in a hand-dug well just north of Basketts house.

Johns Valley shale, Johns Valley, Oklahoma, loc. 5. U. S. National Museum No. 85501.

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[7] Ulrich, E. O., Fossiliferous Boulders in the Ouachita "Caney" Shale and the Age of the Shale Containing Them, *Okla. Geol. Survey*, Bull. 45, 1927.

[8] Powers, Sidney, Age of the Folding of the Oklahoma Mountains—The Ouachita, Arbuckle, and Wichita Mountains of Oklahoma, and the Llano-Burnet and Marathon uplifts of Texas, *Geol. Soc. America, Bull.*, vol. 39, pp. 1042–1046, 1928.

[9] Miser, Hugh D., Structure of the Ouachita Mountains of Oklahoma and Arkansas. *Okla. Geol. Survey*, Bull. 50, pp. 28–29, 1929.

[10] Dixon, E. E. L., The Ouachita Basin of Oklahoma Vis-a-Vis the Craven Lowlands of Yorkshire, *Geol. Mag.*, vol. 68, pp. 337–44, 1931.

[11] Van der Gracht W. A. L. M., Van Waterschoot, Permo-Carboniferous Orogeny in South Central United States, *Am. Assoc. Petroleum Geologists, Bull.*, vol. 15, pp. 991–1057 1931. The Permo-Carboniferous in the South Central United States, *Verh. d. Kon. Akad. van Wetenschappen te Amsterdam.* (Tweede sectie) vol. 27, 1931.

Order FORAMINIFERA d' Orbigny

Family ASTRORHIZIDAE H. B. Brady

Genus HYPERAMMINA H. B. Brady, 1878

HYPERAMMINA ELONGATA CLAVATULA Howchin

Plate 1, figures 1*a–e*

Hyperammina elongata clavatula HOWCHIN. *1888*, Jour. Roy. Micro. Soc., p. 535, pl. 8, figs. 1, 2.

Hyperammina gracilis WATERS, *1927*, Jour. Pal., vol. 1, no. 2, p. 130, pl. 22, figs., 4, 5*a*, *b*.

Test elongate, slender; consisting of a rounded proloculum and a single, somewhat compressed, tubular chamber of uniform diameter throughout, wall finely arenaceous, smooth, aperture formed by the open end of the tube. Length, up to 3 mm.

Johns Valley shale, southern Oklahoma, locs. 1 to 10, A-1, 245, 260, 211, 272, 233, 232, 225, 231, 221, 2–31, A-87, 300, 153, 121, 50, L-37, 82, 87, S-108, 1–2. Plesiotype, U. S. National Museum No. 85502.

HYPERAMMINA JOHNSVALLEYENSIS Harlton, n. sp.

Plate 1, figure 2

Test elongate, tapering, consisting of a proloculum and a single tubular somewhat compressed chamber; wall finely arenaceous; aperture formed by the open end of the tube. Length of holotype, 1.92 mm.; diameter at apertural end, 0.44 mm.

Johns Valley shale, Johns Valley, Oklahoma, loc. 4. Holotype, U. S. National Museum No. 85503.

HYPERAMMINA RUGOSA Waters

Plate 1, figures 3 *a–d*

Hyperammina gracilis var. *rugosa* WATERS, *1927*, Jour. Pal., vol. 1, no. 2, p. 130, pl. 22, figs. 6 *a*, *b*.

Test elongate, straight or gently curved, consisting of a large proloculum and a single tubular chamber; surface smooth, marked at irregular intervals by depressed growth lines; wall arenaceous, aperture terminal, large, round, formed by a slight constriction of the end of the tube. Length, up to 2 mm.; diameter of tube, up to 0.38 mm.; diameter of proloculum, 0.45 mm.

Johns Valley shale, southern Oklahoma, locs. 1, 2, 4, 5, 7, 10, A-1, 260, 290, 225, 231, A-87, 300, 100, L-22, 82,1–2. Plesiotype, U. S. National Museum No. 85504.

HYPERAMMINOIDES Cushman and Waters, 1928

HYPERAMMINOIDES GLABRA (Cushman and Waters)

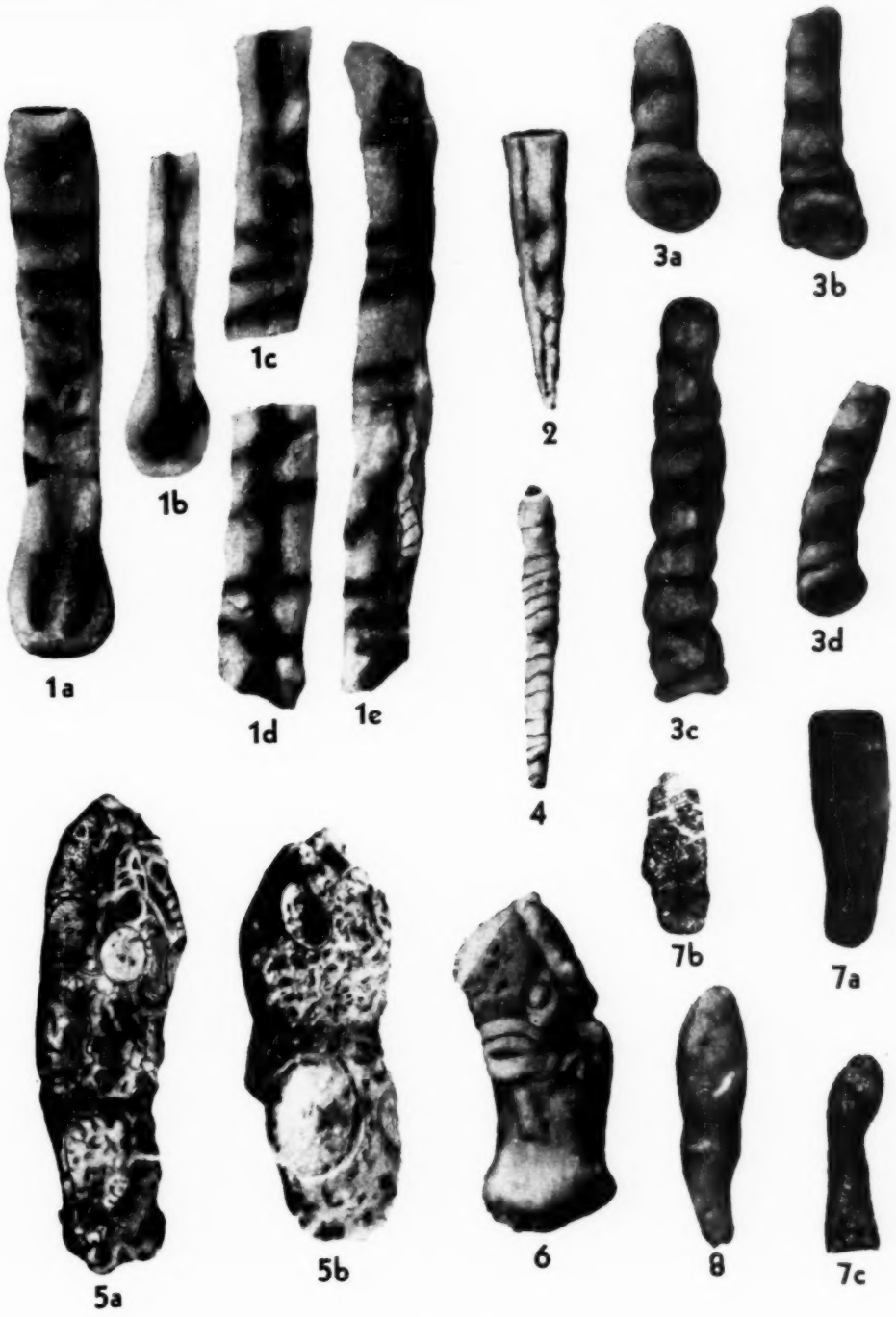
Plate 1, figure 4

Nodosinella glabra CUSHMAN AND WATERS, *1927*, Contr. Cushman Lab. Foram. Res., vol. 3, pt. 3, p. 147, pl. 26, figs. 4, 5.

Hyperamminoides glabra CUSHMAN AND WATERS, *1928*, Jour. Pal., vol. 2, p. 359, pl. 47, figs. 1, 2.

EXPLANATION OF PLATE 1

FIGS. 1 *a–e*—*Hyperammina elongata clavatula* Howchin, ×33.
2—*Hyperammina johnsvalleyensis* Harlton, n. sp. ×22.
3 *a–d*—*Hyperammina rugosa* Waters, ×33.
4—*Hyperamminoides glabra* (Cushman and Waters), ×33.
5 *a*, *b*—*Reophax ouachitensis* Harlton, n. sp., ×33.
6—*Ammovertella inversa* (Schellwien), ×33.
7 *a–c*—*Paleohyperamum pottsvillensis* Harlton, n. sp. *a*, side view ×23, *b*, *c*, longitudinal sections, ×23.
8—*Paleohyperamum* sp., ×33.



Harlton, Johns Valley (Pennsylvanian) fauna

Test slender, straight or gently curved, consisting of a proloculum and a single tubular chamber; surface smooth, marked at irregular intervals by growth lines which are usually slightly depressed; wall finely arenaceous; aperture terminal, large, round, formed by a slight constriction at the end of the test. Length, 1.21 mm.; diameter at apertural end, 0.17 mm.

Johns Valley shale, southern Oklahoma, locs. 5, 11, P-69, 221, 2–31, H-48, Y-10, 50, L-22, S-108. Plesiotype, U. S. National Museum No. 85505.

Genus HIPPOCREPINA Parker, 1870

HIPPOCREPINA BENDENSIS Harlton, n. sp.

Plate 2, figures 7 *a–d*

Stacheia marginulinoides GALLOWAY AND HARLTON, *1928*, (not Brady), Jour. Pal. vol. 2 p. 356, pl. 46, fig. 6.

Test free, or possibly attached, pyriform, elongate, tapering; interior tubular chamber slightly constricted but not divided; wall finely arenaceous, imperforate and insoluble in acid; surface with numerous constrictions caused by growth intervals; aperture at the end of the chamber; length, 1.34 mm. thickness, 0.67 mm.

The early proloculum is not visible in *H. bendensis*, which is probably due to resorption. The growth lines are indeed indicative of a probably early proloculum.

Johns Valley shale, southern Oklahoma, locs. 3, 5, 7, 8, 10, 11, A-1, 10–17, 212, 240, P-69, 2–31, A-87, H-48, 300, 121, L-37, 82, 87. Cotype, U. S. National Museum No. 85506; Longitudinal section No. 85506.

Family REOPHACIDAE Cushman

Genus REOPHAX Montfort, 1908

REOPHAX OUACHITENSIS Harlton, n. sp.

Plate 1, figure 5*a*, *b*

Test elongate, tapering, straight or gently curved, consisting of several chambers, sutures indistinct. Wall arenaceous, composed mainly of agglutinated material, ostracoda, foraminifera and other fossil remains; aperture large terminal. Length, 1.92 mm.; largest diameter, 0.71 mm.

Johns Valley shale, southern Oklahoma, loc. 5. Cotype, U. S. National Museum No. 85507.

Family SPIRILLINIDAE Rhumbler

Genus SPIRILLINA Ehrenberg, 1843

SPIRILLINA BENDENSIS Harlton, n. sp.

Plate 2, figures 3*a–c*

Test minute, nearly circular, biconcave, peripheral margin rounded; whorls three to six; each embracing about half of the previous whorls; surface showing irregular growth lines, wall calcareous, hyaline, with no trace of pores; aperture terminal crescentric. Diameter 0.12 mm. to 0.52 mm.

Johns Valley shale, southern Oklahoma, loc. H-48. Cotype, U. S. National Museum No. 85508.

Family MILIOLIDAE d'Orbigny, 1846

Genus CORNUSPIRA Schultze, 1854

CORNUSPIRA SEMICONSTRICTUS (Waters)

Plate 2, figures 2*a*, *b*

Ammodiscus semiconstrictus WATERS, *1927*, Jour. Pal., vol. 1, no. 2, p. 132, pl. 22, figs. 1 *a–d*.

Test circular to semicircular, plani-

spiral, biconcave, peripheral margin rounded, whorls seven to nine; surface with irregular growth lines; wall calcareous, readily soluble in acid, partly porcellaneous, imperforate; aperture formed by the open end of the tube. Diameter, up to 1.03 mm.

Johns Valley shale, southern Oklahoma, locs. 2, 4, 5, 7, 10, 11, 245, 2–53, 210, P-17, 290, 240, 231, P-69, 220, 300, 100, 50, L-37, L-22, S-108, 1–2. Plesiotype, U. S. National Museum No. 85509.

Genus AMMOVERTELLA Cushman, 1928

AMMOVERTELLA INVERSA (Schellwien)

Plate 1, figure 6

Psammophis inversus SCHELLWIEN, *1898*, Paleontographica, vol. 44, p. 266, pl. 23. fig. 10.
Psammophis inclusus CUSHMAN AND WATERS, *1927*, Contr. Cushman Lab. Foram. Res., vol. 3, pt. 3, p. 148, pl. 26, fig. 12.
Ammovertella inversa CUSHMAN, *1928*, Contr. Cushman Lab. Foram. Res., vol. 4, pt. 1, p. 8.
Calcitornella elongata CUSHMAN AND WATERS, *1928*, Contr. Cushman Lab. Foram. Res., vol. 4, pt. 2, p. 47, pl. 6, fig. 5.
Calcitornella heathi CUSHMAN AND WATERS, *1928*, Contr. Cushman Lab. Foram. Res., vol. 4. pt. 2, p. 48 pl. 6, fig. 8.
Calcivertella adherens CUSHMAN AND WATERS, *1928*, Contr. Cushman Lab. Foram. Res., vol. 4, pt. 2, p. 48, pl. 6, fig. 7.
Ammovertella latimerensis GALLOWAY AND HARLTON, *1928*, Jour. Pal., vol. 2, p. 342, pl. 45, figs. 3, 4.
Ammovertella undulata GALLOWAY AND HARLTON, *1928*, Jour. Pal., vol. 2, p. 341, pl. 45, fig. 2.
Ammovertella adherens GALLOWAY AND RYNIKER, *1930*, Okla. Geol. Survey Circ. 21,, p. 10, pl. 1, fig. 7.

Test adherent, irregular, consisting of a proloculum and tubular second chamber which is coiled planispirally at first and then irregularly back and forth around the early portion, frequently embracing it; wall calcareous, probably imperforate, usually covered with agglutinated material in the later stages; surface smooth in the early coils, later more or less roughened; aperture simple, at the open end of the tube. Diameter of the tube, up to 0.1 mm.

Johns Valley shale, southern Oklahoma, locs. 2, 7, 214, 220, 2–31. Plesiotype, U. S. National Museum No. 85510.

Family ENDOTHYRIDAE Rhumbler

Genus ENDOTHYRA Phillips, 1846

ENDOTHYRA BOWMANI Phillips

Plate 2, figure 4

Endothyra bowmani PHILLIPS, *1846*, Proc. Geol. and Polytech. Soc. W. Riding Yorks., vol. 2, p. 279, fig. 1.

Test nautiloid, asymmetrical, with large umbilici; periphery lobulate; margin rounded sutures straight, depressed; chambers gradually enlarging, eight to ten in the last whorl; wall calcareous, surface very finely punctate; aperture a slit-like opening at the base of the last septal face. Diameter, 0.50 mm.

Johns Valley shale, southern Oklahoma, locs. 245, 2–53, 212, P-69,

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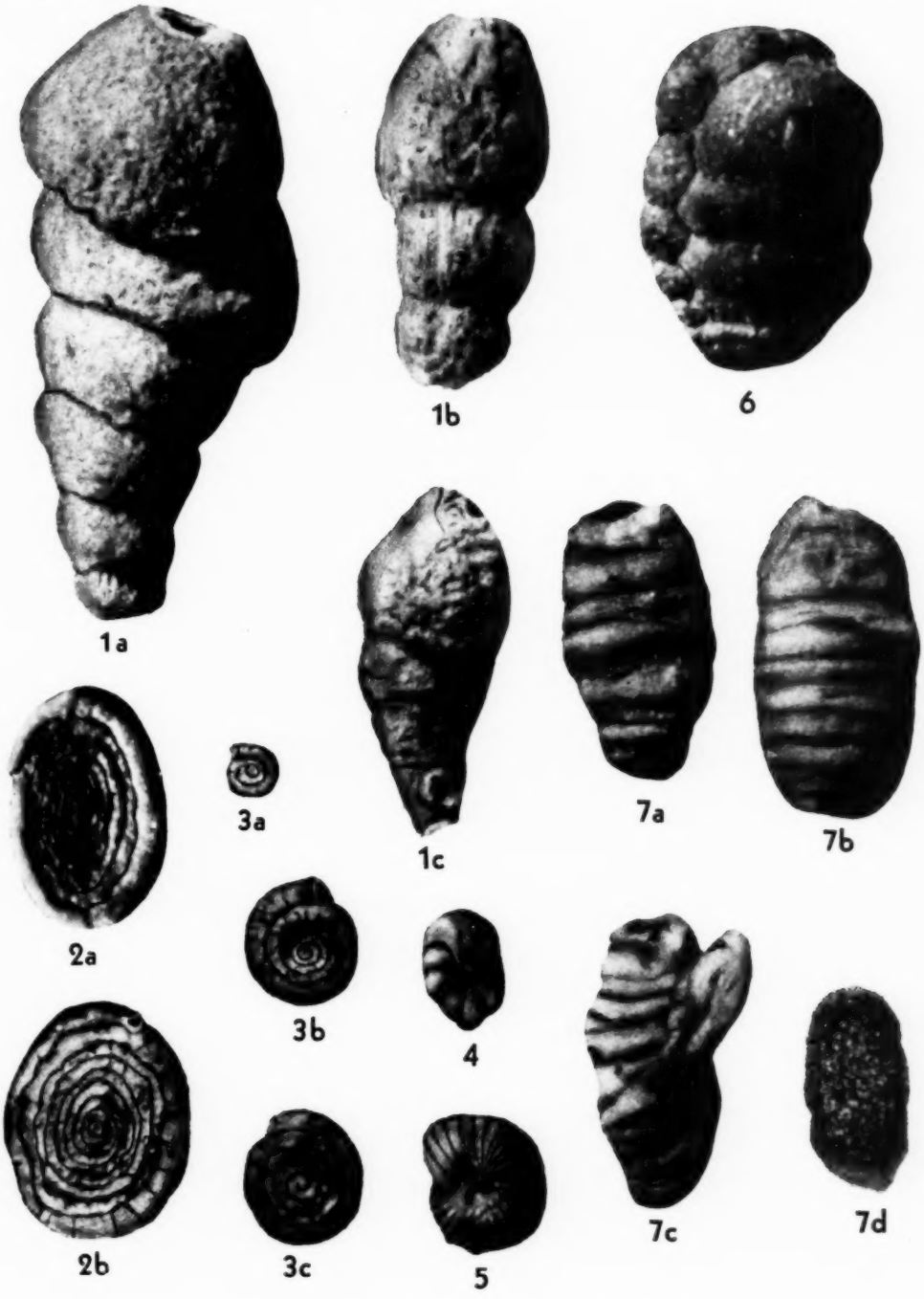
EXPLANATION OF PLATE 2

FIGS. 1 *a–c—Nodosinella glennensis* Harlton, ×33.
2 *a, b—Cornuspira semiconstrictus* (Waters), ×33.
3 *a–e—Spirillina bendensis* Harlton, n. sp. ×33.
4—*Endothyra bowmani* Phillips, ×33.
5—*Orobias ciscoensis* (Harlton), ×33.
6—*Paleotextularia* sp., ×33.
7 *a–d—Hippocrepina bendensis* Harlton n. sp. *a–c*, ×33, longitudinal cross-section, ×21.



Harlton, Johns Valley (Pennsylvanian) fauna

L-37. Plesiotype. U. S. National Museum No. 85511.

Genus OROBIAS Eichwald, 1860

OROBIAS CISCOENSIS (Harlton)

Plate 2, figure 5

Staffella ciscoensis HARLTON, *1928*, Jour. Pal., vol. 1, no. 4, p. 307, pl. 52. fig. 9.
Orobias ciscoensis GALLOWAY AND HARLTON, *1928*, Jour. Pal., vol. 2., p. 350, pl. 45, fig. 11.—Galloway and Ryniker, *1930*, Okla. Geol. Survey, Circ. 21, p. 15, pl. 2, figs. 9 *a*, *b*.

Test lenticular, gently biconvex, closely and symmetrically coiled; back acute or slightly rounded; umbilici depressed in young specimens, faint or absent in adult; chambers 16–25 in the last whorl; sutures distinct, curved, thickened; wall calcareous; surface smooth; aperture a triangular opening on the last septal face. Diameter, 0.58 mm.

Johns Valley shale, southern Oklahoma, locs. 5, 245, 260, 2–53; 212, P-69, 240, H-48. Plesiotype U. S. National Museum No. 85512.

Family NODOSINELLIDAE Rhumbler

Genus NODOSINELLIDA H. B. Brady, 1876

NODOSINELLA GLENNENSIS Harlton

Plate 2, figures 1*a–c*

Nodosinella glennensis HARLTON, *1927*, Jour. Pal., vol. 1, no. 1, p. 17, pl. 1, figs. 4 *a–c*.
Nodosinella laheeii WATERS, *1927*, Jour. Pal., vol. 1, no. 2, p. 131, pl. 22, figs. 8*a*, *b*.

Test elongate, tapering, axis straight or slightly curved, five or six chambers in the adult test, sutures well marked; wall arenaceous, fairly smoothly finished; aperture large, circular, terminal. Length, up to 2.40 mm. or more in adults.

Johns Valley shale, southern Oklahoma, locs. 1, 3, 5, 8, 9, 10, 11, 0–38, 2–53, 210, 212, 233, P-69, 2–31, Y-10, 300, 50, 82, 11–2. Plesiotype, U. S. National Museum No. 85513.

Family TEXTULARIIDAE

Genus PALEOTEXTULARIA Schubert, 1920

PALEOTEXTULARIA sp.

Plate 2, figure 6

This species is rather badly distorted, the test is robust, a rough rectangular pyramid; biserial chambers, about 8 in number; wall thick; aperture single, large at the base of the last chamber. Length, 1.44 mm.; diameter, 0.58 mm.

Johns Valley shale, southern Oklahoma, loc. 4. U. S. National Museum No. 85514.

Order CONODONTA

Family DISTACODIDAE Ulrich and Bassler, 1926

Plate 4, figures 3, 4

At numerous localities there occur smooth, rounded, tapering cusps with the summit portion translucent. Specimens from the Deese formation in the Ardmore basin show these cusps attached to a plate, similar to that in *Bransonella*.

Johns Valley shale, southern Oklahoma, loc. 4.

Genus DISTACODUS Pander, 1856

DISTACODUS OKLAHOMENSIS Harlton, n. sp.

Plate 4, figure 1

A simple, curved, elongate cusp, flaring at base; a distinct depression is on the sides, developing into pronounced anterior elevated keels pointing outward at the flaring basal portion; posteriorly one keel is developed. Cusp cross-section sub-circular to circular. Aboral surface concave.

Johns Valley shale, southern Oklahoma, loc. 4. Holotype, U. S. National Museum No. 85515.

Genus SCOLOPODUS Pander, 1856

SCOLOPODUS STRIATUM Harlton, n. sp.

Plate 3, figure 1

A single, striated cusp attached to root, concave posteriorly; cusp cross-section roughly circular; diameter of cusp; 0.54 mm.; height of holotype included portion of root, 1.11 mm.

Johns Valley shale, southern Oklahoma, loc. 4. Holotype, U. S. National Museum No. 85516.

SCOLOPODUS OKLAHOMENSIS Harlton, n. sp.

Plate 3, figure 6

A single, large, more or less subcircular, striated, tapering cusp, flaring at base; posteriorly strongly concave. Diamter of cusp 0.67 mm. Height of holotype 1.63 mm.

Most specimens observed show the basal attachment to be broken off. This single cusp is found frequently in the Johns Valley shale. Some cusps show evidence of being attached to root.

Johns Valley shale, southern Oklahoma, loc. 4. Cotype, U. S. National Museum No. 85517.

Family PRIONIODIDAE Ulrich and Bassler, 1926

Genus PRIONIODUS Pander, 1856

PRIONIODUS ALTODUS Harlton, n. sp.

Plate 4, figure 2

A very gently backward curved terminal cusp with a very short outward projection and short bar with two moderately strong denticles vertical and thus converging strongly with the main cusp. Bar short, possibly incomplete. Tooth cross-section elliptical.

Johns Valley shale, southern Oklahoma, loc. 5. Holotype, U. S. National Museum No. 85518.

Genus HINDIODELLA Ulrich and Bassler, 1926

HINDIODELLA sp.

Plate 4, figures 6, 7

Anterior and posterior ends of specimens found in the Johns Valley shale (loc. 11), Johns Valley, are broken. U. S. National Museum No. 85519.

Genus LONCHODUS Pander, 1856

LONCHODUS sp.

Plate 4, figure 5

A specimen from Johns Valley referred to this genus is incomplete and

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EXPLANATION OF PLATE 3

All ×32

FIGS. 1—*Scolopodus striatum* Harlton, n. sp.
2—*Multidentodus wapanuckensis* Harlton, n. sp.
3—*Multidentodus johnsvalleyensis* Harlton, n. sp.
4—*Multidentodus typicus* Harlton, n. sp.
5—*Multidentodus gracilis* Harlton, n. sp.
6—*Scolopodus oklahomensis* Harlton, n. sp.
7—*Multidentodus brevis* Harlton, n. sp.
8—*Multidentodus irregularis* Harlton, n. sp.
9 *a–c*—*Bransonella tridentata* Harlton, n. sp.
10 *a–d*—*Holmsella triangularis* Harlton, n. sp.
11 *a, b*—*Holmsella wapanuckensis* Harlton, n. sp.

Harlton, Johns Valley (Pennsylvanian) fauna

imperfect. loc. 5. U. S. National Museum No. 85520.

Genus MULTIDENTODUS Harlton, n. gen.

Distinguished by two or more smooth or striated teeth or tooth-like ridges, usually attached to root. Genoholotype, *Multidentodus johnsvalleyensis* Harlton, n. sp.

MULTIDENTODUS JOHNSVALLEYENSIS Harlton, n. sp.
Plate 3, figure 3

Root carrying 4 striated compact teeth, rapidly narrowing in size, closely overlapping each other, almost forming a single cusp. Diameter of basal margin, 0.65 mm.; height of largest cusp, 0.75 mm.; height of root, 0.58 mm.

Johns Valley shale, southern Oklahoma, loc. A-1. Holotype, U. S. National Museum No. 85521.

MULTIDENTODUS WAPANUCKENSIS Harlton, n. sp.
Plate 3, figure 2

Root carrying 2 striated cusps, anterior being approximately one-fifth size of posterior; concave posteriorly; cusp cross-section nearly circular. Height of anterior cusp 0.48 mm.; posterior cusp 0.58 mm.; diameter of root 0.60 mm.

Johns Valley shale, southern Oklahoma, loc. P-17. Holotype, U. S. National Museum No. 85522.

MULTIDENTODUS TYPICUS Harlton, n. sp.
Plate 3, figure 4

Root carrying 4 elongated, striated cusps, the posterior one being the most prominent, the others graduate smaller anteriorly. The outlines of the cusps are symmetrical to a medio-antero-posterior plane. Diameter of basal margin 1.08 mm.; height of largest cusp 1.06 mm.; height of smallest, 0.33 mm.

Johns Valley shale, southern Oklahoma, loc. A-1. Holotype, U. S. National Museum No. 85523.

MULTIDENTODUS BREVIS Harlton, n. sp.
Plate 3, figure 7

Root with 4 smooth cusps; posteriorly 2 cusps are developed with the largest one carrying 2 closely appressed, overlapping ones anteriorly. Root shallow.

Johns Valley shale, southern Oklahoma, loc. 2–53. Holotype, U. S. National Museum No. 85524.

MULTIDENTODUS IRREGULARIS Harlton, n. sp.
Plate 3, figure 8

Root with 6 indistinctly striated cusps, irregular in arrangement; root of holotype shallow.

Johns Valley shale, southern Oklahoma, loc. H-48. Holotype, U. S. National Museum No. 85525.

MULTIDENTODUS GRACILIS Harlton, n. sp.
Plate 3, figures 5*a*, *b*

Cusp much antero-posteriorly compressed and transversely elongated with sharp oral margin; posterior concave; anterior convex; symmetrical antero-posteriorly; at the anterior a prominent ornamented lobe is developed extending almost to the cutting edge of the cusp, the lateral edges are concave; root shallow.

Johns Valley shale, southern Okla-

homa, loc. 4. Holotype, U. S. National Museum No. 85526.

Genus HOLMESELLA Gunnell, 1931

HOLMESELLA TRIANGULARIS Harlton, n. sp.

Plate 3, figures 10*a–d*

Outline trapezoidal, length approximately equal to width; base robust, strongly pyramidal, asymmetrical triangular in side view, ornamented with faint but distinct transversed lines. Oral surface flat, smooth.

Johns Valley shale, southern Oklahoma, loc. 2–53. Cotype, U. S. National Museum No. 85527.

HOLMESELLA WAPANUCKENSIS Harlton, n. sp.

Plate 3, figures 11*a, b*

Similar to *H. triangularis* but differs in the smaller size and in the oral surface which is ornamented with beautifully arranged, oval-diamond shaped lines. The growth lines transversing the root, seem to absent, however, some specimens suggest evidences of very faint lines.

Johns Valley shale, southern Oklahoma, loc. 2–53. Cotype, U. S. National Museum No. 85528.

Genus BRANSONELLA Harlton, n. gen.

Plate nearly circular convex, with usually three pointed striated cusps, posteriorly with an indented notch; anteriorly at the base a short elongated short ridge usually is developed. Genoholotype, *Bransonella tridentata* Harlton, n. sp.

This genus is named for Dr. E. B. Branson.

BRANSONELLA TRIDENTATA Harlton, n. sp.

Plate 3, figures 9*a–c*

Basal plate nearly circular, convex with three pointed anteriorly, striated cusps; posteriorly a triple-indented notch is developed; anteriorly at the base a short-elongated ridge is developed. Viewed anteriorly the striations carry through from one cusp to the other. The striae appear to have the tendency to carry through from lateral to lateral cusp. Height from base to lateral cusp of holotype 0.77 mm.; width of basal margin 1.0 mm.

Johns Valley shale, southern Oklahoma, loc. 5. Holotype, U. S. National Museum No. 85529.

Family POLYGNATHIDAE Ulrich and Bassler, 1926

Plate 4, figures 8–12

At many localities in the Ouachitas fragments of posterior bars belonging to the above family were found. The complete tooth is rarely found and

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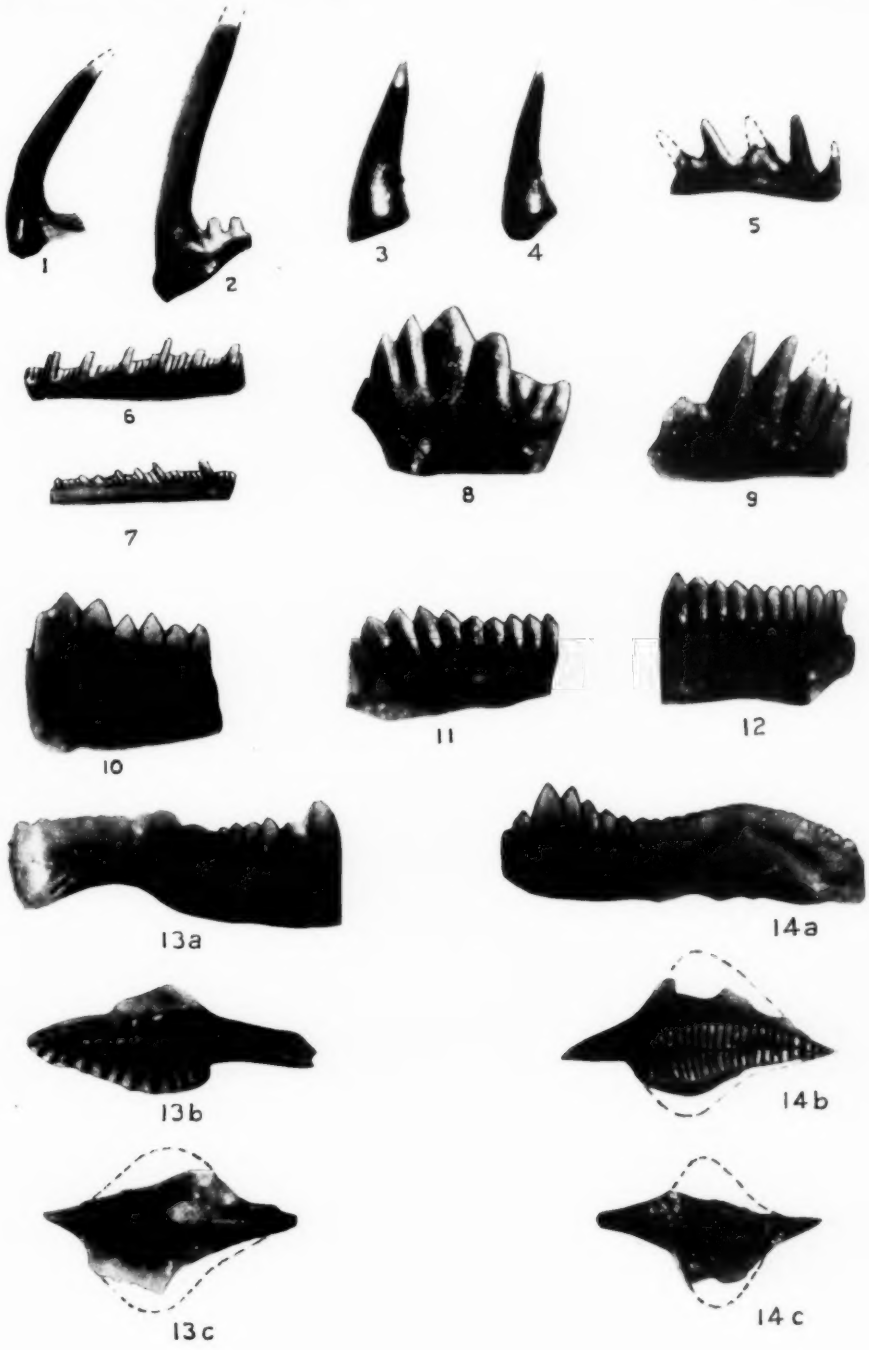
EXPLANATION OF PLATE 4

All ×32

FIGS. 1—*Distacodus oklahomensis* Harlton, n. sp.
2—*Prioniodus altodus* Harlton, n. sp.
3, 4—Cusp belonging to Distacodidae.
5—*Lonchodus* sp.
6, 7—*Hindiodella* sp.
8–12—Posterior fragments of *Polygnathus.*
13 *a–c*—*Polygnathus wapanuckensis* Harlton, n. sp.
14 *a–c*—*Polygnathodella ouachitensis* Harlton, n. sp.



Harlton, Johns Valley (Pennsylvanian) fauna

the fragments, due to their relative abundance, may serve as markers rather than the teeth.

Johns Valley shale, southern Oklahoma, locs. 1, 4, 5, 7, 8, 11, W-17, H-48, L-22, S-108.

Genus POLYGNATHUS (Hinde) Bryant, 1921

POLYGNATHUS WAPANUCKENSIS Harlton, n. sp.

Plate 4, figures 13*a–c*

Plate lanceolate in outline posterior bar with denticles; oral surface with transversed distinct carina; longitudinal central ridge distinct carrying nodes. Aboral surface of plate concave with longitudinal groove, separating the two sub-equal areas.

Johns Valley shale, southern Oklahoma, loc. 11. Cotype, U. S. National Museum No. 85530.

Genus POLYGNATHODELLA Harlton, n. gen.

Similar to *Polygnathus*, but posterior bar extends along margin of oral surface. Genoholotype, *Polygnathodella ouachitensis* Harlton, n. sp.

POLYGNATHODELLA OUACHITENSIS Harlton, n. sp.

Plate 4, figures 14*a–c*

Plate lanceolate in outline, posterior bar with denticles; oral surface with transversed distinct carinae; posterior bar connected with upper margin of oral surface. The carinae at lower oral surface coincide with the upper ones, posteriorly it has the tendency to incurve.

Johns Valley shale, southern Oklahoma, loc. 2–53. Holotype, U. S. National Museum No. 85531.

Phylum VERMES

At various localities small worms are found. The preservation of these forms is poor and no illustrations are given at the present time.

Class BRYOZOA Ehrenberg

Family BATOSTOMELLIDAE Ulrich

Genus LEIOCLEMA Ulrich, 1882

LIOCLEMA PUSHMATAHENSIS Harlton, n. sp.

Plate 5, figures 9–11

Zoarium ramose, diameter 0.73 to 1.02 mm. Zooecia typically elliptical, sometimes indented by large acanthopores. Mesopores abundant, rounded or sub-polygonal in outline, one to three rows between apertures. Acanthopores strongly developed and abundant between zooecia and mesopores, projecting from the surface so as to give the zoarium a distinctly hirsute appearance. Longitudinal and transverse sections show the outer cortical regions to have an average thickness of about 0.15 to 0.19 mm., and the axial region a diameter of about 0.58 mm.

Johns Valley shale, southern Oklahoma, loc. H-48. Holotype, U. S. National Museum No. 85532, Longitudinal section, No. 85532. Transverse section, No. 85532.

Family FENESTELLIDAE King

Genus FENESTELLA Lonsdale, 1839

FENESTELLA GRANDIS Harlton, n. sp.

Plate 5, figures 7–8

Zoarium finely reticulate; branches straight, up to 0.42 mm. in width;

about 5 in 3 mm.; dissepiments thick about 5 in 4 mm. Zooecia with circular apertures, 0.1 mm. in diameter, surrounded by a peristome most elevated on the outside of the branch, one at the base of each dissepiment and two in between; about 6 in 1.34 mm. Obverse side of branches with a low median keel which bears distinct spines at intervals of about 0.19 to 0.27 mm.; fenestrules elongate, usually filled with cementing material, 0.44 mm long by 0.17 mm. wide; reverse side of the branches granulose, sometimes with indistinct longitudinal striae.

Johns Valley shale, southern Oklahoma, loc. 4. Cotype U. S. National Museum No. 85533.

FENESTELLA OKLAHOMENSIS Harlton, n. sp.
Plate 5, figure 14

Zoarium reticulate, branches straight, 0.28 mm. in width, about 7.5 occurring in 3 mm.; dissepiments thin, about 7.5 in 3 mm. Zooecia in two alternating rows on each branch, about 10 in 1.92 mm.; apertures circular, 0.12 mm in diameter, surrounded by a peristome, most elevated on the outside of the branch, one at the base of each dissepiment and one in between. Fenestrules moccasin-shaped, 0.29 mm. long by 0.13 mm. wide. Obverse and reverse side of branches marked by reticulated longitudinal striae.

This species agrees rather closely with the measurements of *F. tenax* Ulrich, but the two are not likely to be confounded.

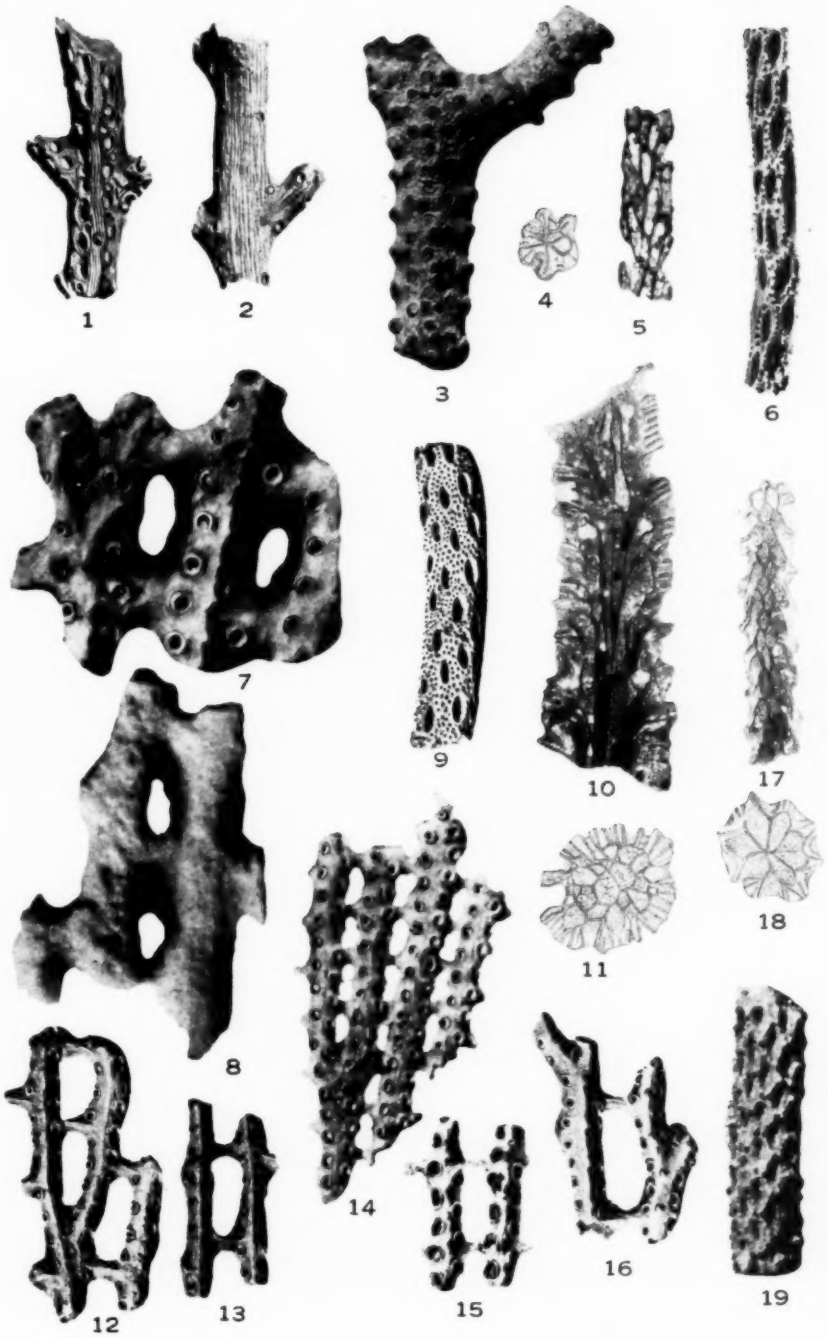
Johns Valley shale, southern Oklahoma, loc. 4. Holotype U. S. National Museum No. 85534.

FENESTELLA BENDENSIS Harlton, n. sp.
Plate 5, figures 12–13

Zoarium finely reticulate, branches straight or slightly flexuous, 0.29 to 0.36 mm. in width, about 5.5 in 3 mm.; dissepiments thin about 5 in 5 mm. Zooecia with circular apertures 0.11 mm in diameter, surrounded by a peristome most elevated on the outside of the branch, one at the base of each dissepiment and two in between, about 7 in 1.83 mm. Obverse side of branches bears a low median keel with no apparent evidence of spines; fenestrules elongate-ovate shaped, 0.77 mm. long by 0.29 mm. wide; re-

EXPLANATION OF PLATE 5

FIGS. 1, 2—*Acanthocladia ouachitensis* Harlton, n. sp. 1, portion of the obverse side of cotype; 2, reverse side of cotype.
3—*Cystodictya elegans* Harlton, n. sp., ×17.
4–6—*Rhombopora nitidula* Harlton, n. sp. 4, Transverse section of a specimen, ×20; 5, longitudinal section of same, ×20; 6, surface view of holotype, ×13.
7, 8—*Fenestella grandis* Harlton, n. sp., ×17. 7, Observe side; 8, reverse side.
9–11—*Lioclema pushmatahensis* Harlton, n. sp. 9, Surface view of holotype, ×13; 10, longitudinal section of another specimen, ×22; 11, transverse section of same, ×22.
12, 13—*Fenestella bendensis* Harlton, n. sp. ×13.
14—*Fenestella oklahomensis* Harlton, n. sp. ×17.
15—*Fenestella kosomensis* Harlton, n. sp. ×17.
16—*Fenestella granularis* Harlton, n. sp. ×13.
17–19—*Rhombopora johnsvalleyensis* Harlton, n. sp. 17, Longitudinal section of a specimen, ×13; 18, transverse section of same, ×22; 19, surface view of holotype, ×13.



Harlton, Johns Valley (Pennsylvanian) fauna

verse side of branches marked by longitudinal striae.

Johns Valley shale, southern Oklahoma, loc. 5. Cotype, U. S. National Museum No. 85535.

FENESTELLA KOSOMENSIS Harlton, n. sp.
Plate 5, figure 15

Zoarium reticulate; branches straight, 0.27 mm. in width, about 6 occurring in 3 mm.; dissepiments thin, about 4.5 in 3 mm. Zooecia with circular apertures 0.17 mm. in diameter, surrounded by a peristome most elevated on the outside of the branch, one at the base of each dissepiment and one between, about 5 in 1.17 mm. Obverse side of branches with a low median keel which bears spinose tubercles at intervals of about 0.38 mm. Fenestrules elongate, 0.54 mm. long by 0.21 mm. wide, reverse side of the branches marked by longitudinal striae.

Johns Valley shale, southern Oklahoma, loc. 5. Holotype, U. S. National Museum No. 85536.

FENESTELLA GRANULARIS Harlton, n. sp.
Plate 5, figure 16

Zoarium a minutely granulated expansion; branches straight to slightly flexuous, about 0.36 mm. in width, 4 occurring in 3 mm.; dissepiments thin, about 4 in 5 mm. Zooecia with circular apertures, 0.13 mm. in diameter, surrounded by a peristome that is most elevated on the outside of the branch, one at the base of each dissepiment and 4 between, about 7 in 1.54 mm. Obverse side of branches with a low median keel which bears distinct spines at intervals of about 0.42 mm.; fenestrules elongate-ovate, 1.02 mm. long by 0.42 mm. wide; reverse side rather strongly granulostriated, bearing short but distinct spines at the middle of the branches at intervals of about 0.31 mm.

Johns Valley shale, southern Oklahoma, loc. 214. Holotype, U. S. National Museum No. 85537.

Family ACANTHOCLADIIDAE Zittel

Genus ACANTHOCLADIA King, 1850

ACANTHOCLADIA OUACHITENSIS Harlton, n. sp.
Plate 5, figures 1, 2

Zoarium pinnate, midrib robust, about 0.58 mm. in width and nearly as thick. Pinnae rather short, about 0.4 mm. wide at the base, somewhat tapering to the end, nearly opposite or in alternating position on each side of the midrib; the distance between pinnae varies from 1.34 to about 2 mm. The pinnae extend at an angle of about 45 degrees from the midrib. Zooecial apertures circular, 0.15 mm. in diameter, surrounded by a distinct peristome, arranged in two alternating ranges on midrib and pinnae, about 6.5 occurring in 2 mm. Small accessory pores are about as numerous as the zooecia on the obverse face. Obverse face of midrib and pinnae bearing along the median portion a slightly flexuous, somewhat elevated, slightly rounded keel with usually 4 to 5 pronounced longitudinal striae, the combined width of the striae measuring 0.13 mm.; the keel of the midrib and pinnae carrying moderately strong nodes which in most cases are 1.15 mm. apart. Obverse and reverse side is marked

by distinct longitudinal striae and the latter bears scattered accessory pores.

Johns Valley shale, southern Oklahoma, loc. H-48. Cotype, U. S. National Museum No. 85538.

Family RHABDOMESONTIDAE Vine

Genus RHOMBOPORA Meek, 1872

RHOMBOPORA NITIDULA Harlton, n. sp.

Plate 5, figures 4–6

Zoarium slender, about 0.48 mm. in diameter; apertures elongate, about 0.29 by 0.10 mm., about 5 occurring in 2 mm. longitudinally. Interspaces between zooecia are narrow, carrying a single row of prominent acanthopores. Diagonal series of apertures intersect at a rather irregular angle. It requires usually 6 zooecia to form one oblique volution about the stem.

This species differs from *R. angustata* Ulrich, mainly in the larger size of the apertures and the distinct smaller size of the interspaces.

Johns Valley shale, southern Oklahoma, loc. H-48. Holotype, U. S. National Museum No. 85539, Longitudinal section No. 85539, Transverse section No. 85539.

RHOMBOPORA JOHNSVALLEYENSIS Harlton, n. sp.

Plate 5, figures 17–19

Zoarium cylindrical, about 0.65 to 0.82 mm. in diameter, apertures rather narrow elongate elliptical, 0.19 by 0.10 mm.; surrounded by a steeply sloping vestibular area. Interspaces between the zooecia are rather narrow, carrying a row of bead-like, prominent acanthopores; acanthopores larger than the average size are found at the end of the apertures. Apertures arranged regularly in longitudinal and diagonal series which intersect each other at the angle of about 45 degrees. Longitudinally there are about 4 apertures in 1.60 mm.

Johns Valley shale, southern Oklahoma, loc. 11. Holotype, U. S. National Museum No. 85540, Longitudinal Section No. 85540, Transverse section No. 85540.

Genus CYSTODICTYA Ulrich, 1882

CYSTODICTYA ELEGANS Harlton, n. sp.

Plate 5, figure 3

Zoarium a compressed elliptical, bifurcating, reticulated stipe, the angles of bifurcating branches about 90 degrees, width about 0.67 mm.; thickness 0.38 mm., nonporiferous

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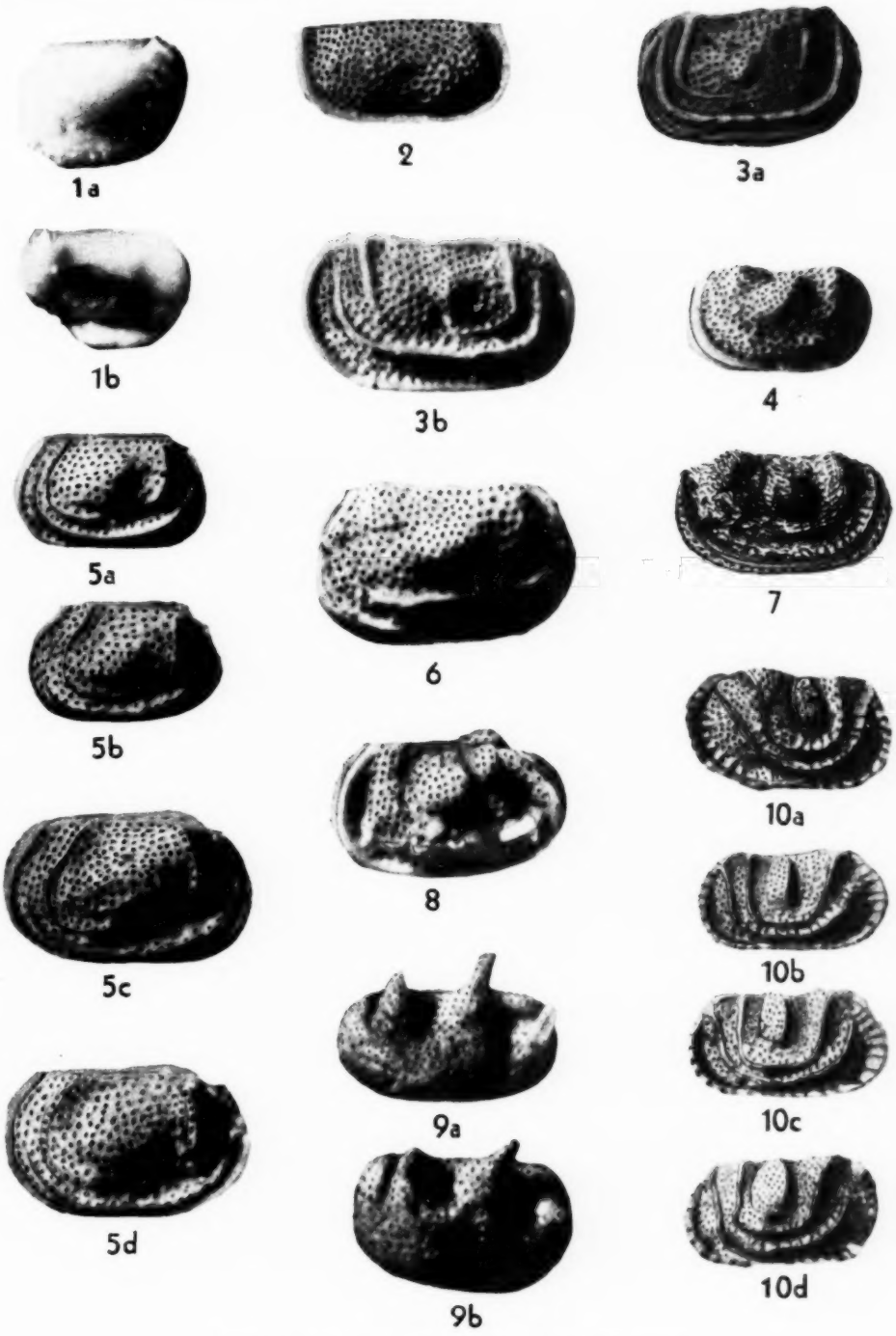
EXPLANATION OF PLATE 6

FIGS. 1 *a, b*—*Paraparchites wapanuckaensis* Harlton ×33.
2—*Kirkbya bendensis* Harlton, n. sp. ×33.
3 *a, b*—*Amphissites marginiferus* Roth ×33.
4—*Amphissites nodosus* Roth ×25.
5 *a–d*—*Amphissites rugosus* Girty ×33.
6—*Amphissites* sp. ×33.
7—*Amphissites miser* Harlton, n. sp. ×32.
8—*Amphissites wapanuckensis* Harlton ×33.
9 *a–d*—*Amphissites bushi* Harlton n. sp. ×26.
10–*a, b*—*Aechminella trispinosa* Harlton n. sp. ×33.



Harlton, Johns Valley (Pennsylvanian) fauna

margin evenly rounded. The distance between zooecia on opposite sides of the zoarium is about 0.17 mm. at the narrow margin and 0.23 mm. at the wide margin. Apertures circular, surrounded by an inconspicuous peristome at the narrow margin, the peristomes are very pronounced at the wide nonporiferous margin. Average dimensions in the row adjoining wide margin are, including peristomes, 0.12 mm., inside measurements 0.08 mm.; near narrow margin, including peristomes, 0.13 mm.; inside 0.10 mm. There are three longitudinal ranges of zooecia, 6 apertures occur in about 1.82 mm. on the side toward the wide margin, and 7 in about 2.0 mm. on the side toward the narrow margin. Obverse side bears conspicuous spines at intervals of 7 in about 2 mm. Reverse side with longitudinal striae.

Johns Valley shale, southern Oklahoma, loc. 8. Holotype, U. S. National Museum 85541.

Order OSTRACODA Latreille

Family APARCHITIDAE Ulrich and Bassler

Genus PARAPARCHITES Ulrich and Bassler, 1906

PARAPARCHITES WAPANUCKENSIS Harlton

Plate 6, figures 1*a*, *b*

Paraparchites wapanuckensis HARLTON, *1928*, Jour. Pal., no. 2, p. 132, pl. 21, figs. 1 *a*, *b*. *1929*, Am. Jour. Sci., vol. XVIII, p. 255, pl. 1, figs. 3*a*, *b*.

Carapace obliquely subovate in lateral view, the largest diameter being from the antero-dorsal to the postero-ventral region at low angle; hinge-line straight, anterior end low, cardinal angles moderately sharp. At the swollen antero-cardinal portion of each value is a prominent spine. Surface smooth. Length, 0.71 mm.; height, 0.52 mm.; thickness, 0.33 mm.

Johns Valley shale, southern Oklahoma, locs. 210, 212, 292, P-69, 220, Y-10, L-22, 1-2. Plesiotype U. S. National Museum No. 85542.

Family BEYRICHIIDAE Jones

Genus CORNIGELLA Warthin, 1930

CORNIGELLA PUSHMATAHENSIS Harlton, n. sp.

Plate 7, figure 2

Carapace subquadrate in lateral view, ends smoothly rounded, cardinal angles obtuse, inconspicuous hinge-line straight, ventral margin curved, with greatest height posteriorly; surface of each valve exhibiting eight rounded elevated nodes and six small nodes spaced at nearly equal intervals just along the margins. There are two prominent nodes along the hinge-line, the anterior one best developed, extending above the hinge-line. Surface very finely reticulated. Length, 0.48 mm.; height, 0.29 mm.; thickness, 0.16 mm.

Immediately below the posterior central node is a smooth surface giving the appearance of a muscle-spot; however, its position suggests that this spot must have been caused by fossilization.

Johns Valley shale, southern Oklahoma, loc. 6. Holotype, U. S. National Museum No. 85543.

Genus AECHMINELLA Harlton, n. gen.

Carapace small, subquadrate greatest thickness central; hinge-line

straight; valves probably unequal, left valve appears to overlap right, but this may be due to deformation; surface ornamented by three large spines on each valve and sometimes by the presence of an anterior and posterior vertical ridge; reticulation distinct. Genoholotype, *Aechminella trispinosa* Harlton, n. sp.

AECHMINELLA TRISPINOSA Harlton, n. sp.
Plate 6, figures 10*a*, *b*

Carapace small, subquadrate in lateral view; ends smoothly rounded, cardinal angles obtuse, inconspicuous; hinge-line straight; ventral margin slightly curved; surface of each valve exhibiting three very large spines; at the outward anterior portion is a deep impression and in front of it is a ridge with one of the large spines. At the dorso-posterior angle another deep impression and ridge is developed; surface distinctly reticulated. Length, 0.9 mm.; height, to 0.54 mm.; thickness, 0.22 mm.

Johns Valley shale, southern Oklahoma, loc. 10. Holotype, U. S. National Museum No. 85544.

AECHMINELLA BUCHANANI Harlton, n. sp.
Plate 7, figures 1*a*, *b*

Carapace small, subquadrate in lateral view, end smoothly rounded; cardinal angles obtuse, inconspicuous; hinge straight, ventral margin slightly rounded with distinct backward swing; valves probably unequal, left valve appears to overlap right, which may be due to deformation; surface of each valve exhibiting three large spines, two prominent ones being along the hinge-line and a smaller one at the outward anterior portion; reticulation distinct. Length, to 1.04 mm.; height, to 0.67 mm.; thickness, 0.42 mm.

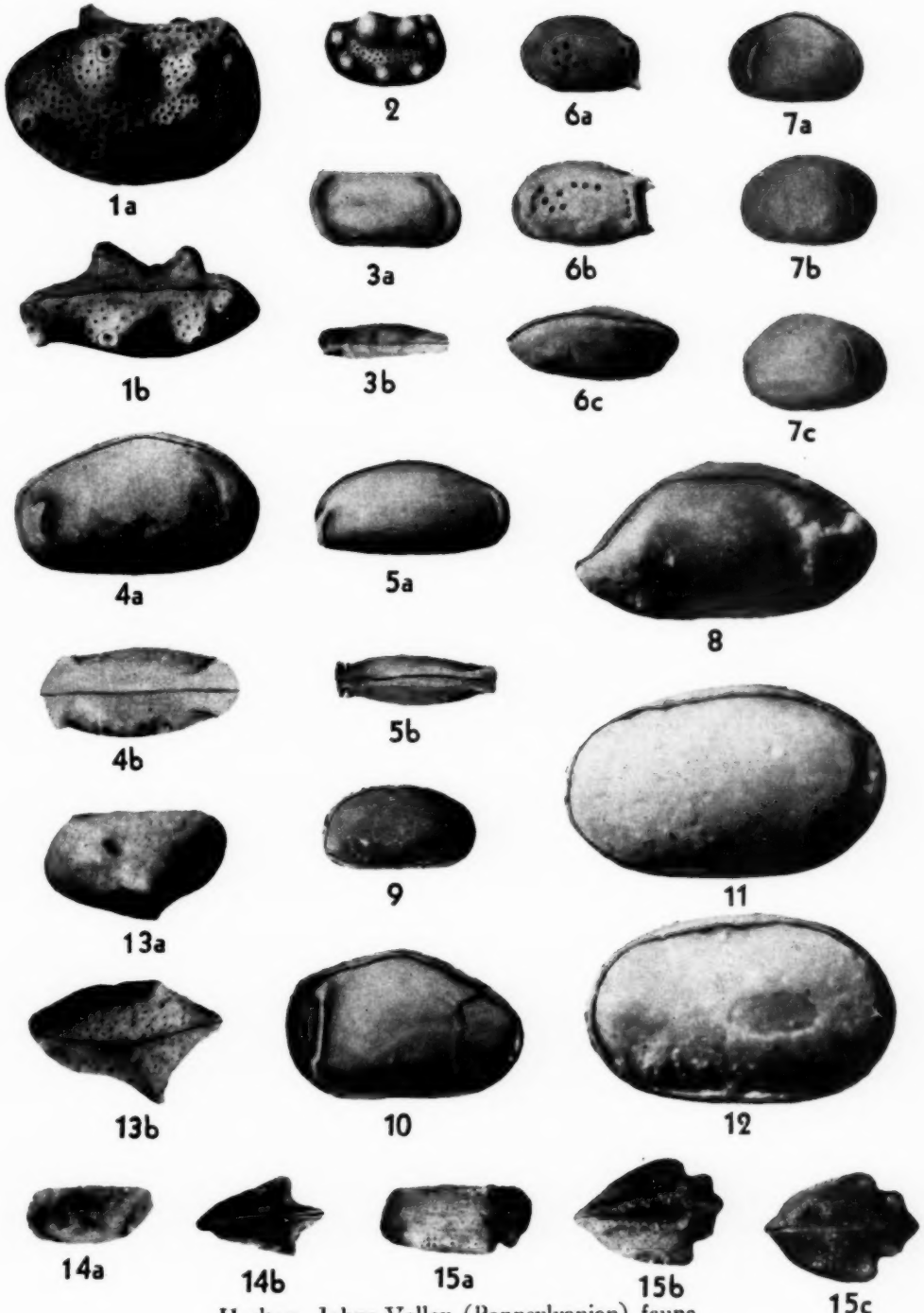
This species differs from *A. trispinosa* in the absence of the vertical anterior and posterior ridge, smaller spines, and in the distinct backward swing at the ventro-posrtrioe margin.

This species is named for George S. Buchanan.

Johns Valley shale, southern Oklahoma, loc. 5. Cotype, U. S. National Museum No. 85545.

EXPLANATION OF PLATE 7

Figs. 1 *a*, *b*—*Aechminella buchanani* Harlton, n. sp. ×33, *a*, side view; *b*, dorsal view.
2—*Cornigella pushmatahensis* Harlton, n. sp. ×33.
3 *a*, *b*—*Youngiella wapanuckensis* Harlton, n. sp. ×33, *a*, side view; *b*, dorsal view.
4 *a*, *b*—*Seminolites kosomensis* Harlton, n. sp. *a*, side view ×33, *b*, dorsal view, ×29.
5 *a*, *b*—*Seminolites pushmatahensis* Harlton, n. sp. *a*, side view ×33, *b*, dorsal view, ×29.
6 *a–e*—*Seminolites perforatus* Harlton, n. sp. ×33, *a*, *b*, side view; *c*, dorsal view.
7 *a–c*—*Healidia simplicissima* Harlton, n. sp. ×33.
8—*Bairdia ardmorensis* Harlton ×33.
9—*Bythocypris tomlinsoni* Harlton ×25.
10—*Healdia caneyensis* Harlton ×33.
11—*Cavellina subovata* Coryell ×33.
12—*Cavellina lata* Coryell ×33.
13 *a*, *b*—*Monoceratina ventralis* Roth, ×33, *a*, side view; *b*, dorsal view.
14 *a*, *b*—*Moneceratina ardmorensis* Harlton, ×25, *a*, side view; *b*, ventral view.
15 *a–c*—*Mooreina johnsvalleyensis* Harlton n. sp. *a*, side view; *b*, dorsal view; *c*, central view ×43.



Harlton, Johns Valley (Pennsylvanian) fauna

Genus MOOREINA JOHNSVALLEYENSIS Harlton, n. gen.

Carapace small, sub-ovate, dorsal view roughly triangular; hinge-line straight. Valves probably unequal, indication of slight overlap of right valve over left ventrally. Surface ornamented with a wing-like protuberance at the side, and a dorso- and ventro-anterior node. Surface finely granulated and pitted. Genoholotype, *Mooreina johnsvalleyensis* Harlton, n. sp.

This genus is named for Dr. R. C. Moore.

MOOREINA JOHNSVALLEYENSIS Harlton, n. sp.

Plate 7, figures 15*a–c*

Carapace sub-ovate in outline; viewed from above, the shape is triangular; hinge-line straight, ventral area broadly flattened standing out in a wing-like protuberance at the side; dorso-anterior node extending above the hinge-line about one-fourth length of valve; ventral border flat, ornamented with discontinuous faint parallel lines which gives the appearance of pitting. About one-fifth the length of the valve at the ventro-anterior portion another prominent node on each valve is developed; the lateral surface of valve is smoothly confluent with the wing-like protuberance; ends bluntly rounded. Indication of slight overlap of right valve over left ventrally. Surface minutely granular and very fine pits on the upper part of wing. Length, 0.53 mm.; height, 0.29 mm.; thickness, 0.38 mm.

Johns Valley shale, southern Oklahoma, loc. 5. Holotype, U. S. National Museum No. 85546.

Genus MONOCERATINA Roth, 1928

MONOCERATINA VENTRALIS Roth

Plate 7, figures 13*a*, *b*

Monoceratina ventrale ROTH, *1928*, Jour. Pal., vol. 2, p. 16.

Carapace subovate in outline; hinge-line straight; on posterior extremity the ventral margin is boldly rounded, meeting the hinge-line at obtuse angle; anterior angle obtuse; ventral margin more or less straight, curving gradually into the rounded ends; near anterior part of ventral margin is a sharp little horn; anteriorly from this point the horn-like flange drops back to the carapace at about right angles and rapidly fades into the very sharp anterior keel of the ventral margin. Length, 0.79 mm., height, 0.38 mm.

Johns Valley shale, southern Oklahoma, locs. 2, 210, 212, 214, P-69, 225, Y-10, 50, L-22. Plesiotype, U. S. National Museum No. 85547.

MONOCERATINA ARDMORENSIS (Harlton)

Plate 7, figures 14*a*, *b*

Cythereis ? ardmorensis HARLTON, *1927*, Jour. Pal., vol. 1, p. 211, pl. 33. figs. 14 *a–c*; *1929*, Am. Jour. Sci., vol. 18, p. 270, pl. 2, figs. 18 *a*, *b*.

Carapace sub-ovate in outline, viewed from above the shape is triangular; hinge-line straight, cardinal angles moderately sharp; anterior extremity sharply rounded, posterior well rounded; ventrally near the anterior portion is a conspicuous wing-like protuberance. Surface minutely reticulated, the markings being visible only under high magnification. Length, 0.72 mm.; height, 0.34 mm.; width, 0.47 mm.

The spines at the extremities which

were thought to be present on the holotype are caused by the roughness of the surface.

Johns Valley shale, southern Oklahoma, locs. P-17, P-69, H-48.

Family KIRKBYIDAE Ulrich and Bassler

Genus KIRKBYA Jones, 1859

KIRKBYA BENDENSIS Harlton, n. sp.

Plate 6, figure 2

Carapace elongate, subquadrate in lateral view; anterior end rather squarely rounded meeting the straight hinge-line at a sharp angle; posterior end curves roundly, with dorso-posterior angle less pronounced; ventral border almost straight, meeting the ends smoothly; marginal frill pronounced. Viewed from the ventral side, there is a smooth area between the free margin of the outer edge of the frill on the left valve and a small carina at the center; this same area on right valve is much narrower; on extreme edge of the left valve is a very faint carina; on right valve is a very faint carina at the edge of overlapping left valve. The smooth hinge-line is slightly depressed along its center length. At the dorso-anterior portion is a distinct but not pronounced shoulder, smoothly rounded and not extending above the hinge-line. Central muscle spot, indistinct, slightly depressed, ill defined. Surface coarsely reticulated. Length, 0.9 mm.; height, 0.44 mm.; thickness, 0.38 mm.

Johns Valley shale, southern Oklahoma, loc. P-17. Holotype, U. S. National Museum No. 85548.

Genus AMPHISSITES Girty, 1910

AMPHISSITES RUGOSUS Girty

Plate 6, figures 5*a–d*

Amphissites rugosus GIRTY, *1910*, Annals. N. Y. Acad. Sci., vol. 20, p. 236.
Amphissites weaveri ROTH, *1929*, Pub. Wagner Free Inst., vol. 1, p. 39, pl. 2, figs. 11 *a–c*.

Carapace subquadrate in lateral view; ends nearly rounded, meeting the hinge-line with nearly identical angles, ventral margin straight, curving gradually into the rounded ends, margin rather narrow, smooth; conspicuous marginal frill with a single row of reticulations on its ventral side extending upward to both cardinal angles; inner strong frill separated on ventral border by 3 or 4 rows of reticulations from the marginal frill; anterior and posterior nodes carinate, with a strong shoulder at the anterior and posterior carinae running downward to about 2 or 3 reticulation pits above the parallel inner marginal frill; medium central node large; kirkbyian pit rather small, situated at the antero-ventral side of the median node. Reticulations distinct. Length, to 1.19 mm.; height, to 0.77 mm.; thickness, to 0.69 mm.

Ephebic forms are rather strongly inflated throughout, the anterior shoulder and inner carinae are less conspicuous, becoming more or less confluent to the whole shell. Between the two innermost carinae the reticulations become conspicuous, giving the appearance of another carina. The innermost carina also has a tendency to disconnect ventrally.

Amphissites weaveri Roth was pro-

posed as a new species following comparison of types with a photograph of *A. rugosus*, which failed to reveal that types were identical.

Johns Valley shale, southern Oklahoma, locs. 11, 2–52, P-17, P-69, H-48. Plesiotype, U. S. National Museum No 85549.

AMPHISSITES MARGINIFERUS Roth
Plate 6, figures 3*a*, *b*

Amphissites marginifera ROTH, *1929*, Pub. Wagner Free, Inst., vol. 1, p. 45 pl. 3, figs. 14*a–c*.

Carapace oblong-subquadrate in outline; cardinal angles obtuse; hinge-line depressed, straight anterior and posterior ends well rounded, posterior usually more pronounced; margin narrow, smooth; marginal frill with a single row of reticulations on its ventral side extending upward to both cardinal angles; inner frill separated on the ventral border by three or four rows of reticulations from the marginal frill; anterior and posterior nodes carinate, the carinae at the anterior short, posterior running downward to about two or three pits above the inner marginal frill and paralleling it for about three to five reticulations before disappearing; median central node small. Kirkbyian pit large, situated on the antero-ventral side of the median node. Reticulations rather strong. Length, 1.15 mm.; height, 0.63 mm.; thickness, 0.48 mm.

Johns Valley shale, southern Oklahoma, locs. 5, 9, 2–53, W-17, 212, P-17, 214, P-69, H-48, L-22. Plesiotype, U. S. National Museum No. 85550.

AMPHISSITES NODOSUS Roth
Plate 6, figure 4

Amphissites nodosum ROTH, *1929*, Pub. Wagner Free Inst., vol. 1, p. 50, pl. 3, figs. 16*a–c*.

Carapace oblong-subquadrate in outline; hinge-line straight, cardinal angles obtuse; anterior and posterior ends well rounded; ventral border straight or slightly curved; margin narrow smooth; surface exhibiting three prominent nodes; the most prominent anterior ridge-like node extends above the hinge-line and is at right angles to it, the small posterior ridge-like node extends slightly above the hinge-line, both ridges extending downward close to the marginal frill, forming a shelf-like elevation. Median node large, nearly hemispherical. Kirkbyian pit immediately below central node. Reticulations rather strong. Length, 1 mm.; height, 0.58 mm.

Johns Valley shale, southern Oklahoma, locs. 2–52, P-17.

AMPHISSITES sp.
Plate 6, figure 6

This species is badly distorted and resembles *A. nodosus* in its strong shoulders but differs in the moderate central node, weak posterior node, and in the distinct inner frill which is situated half-way between the outer frill and node. Reticulations strong. Length, 1.08 mm.; height, 0.60 mm.; thickness, 0.58 mm.

Johns Valley shale, southern Oklahoma, loc. 10. Cat. No. 85551 U. S. National Museum.

AMPHISSITES WAPANUCKENSIS Harlton
Plate 6, figure 8

Amphissites wapanuckensis HARLTON, *1929*, Am. Jour. Sci., vol. 18, p. 257, pl. 1, figs. 4*a,b*.

Carapace small, oblong-subquadrate in outline, with thick flattened edges; hinge-line straight, cardinal angles moderately sharp; anterior and posterior ends well rounded, posterior usually more pronounced; ventral border straight or very slightly curved. Valves with a prominent large central node, and another large node on the antero-dorsal angle. On the dorso- and ventro-anterior portions is a pronounced elevation which usually thickens toward the center of the shell. A long, very strong, elevated, curved, ridge-like frill, which rapidly increases in size toward the ventro-anterior portion, and which breaks abruptly toward the ventral fourth, is situated near the ventral border. Immediately below central node is a small ovate pit; surface of valve rather largely reticulated. Length, 0.96 mm.; height, 0.54 mm.; thickness, 0.48 mm.

Johns Valley shale, southern Oklahoma, locs. 5, 10. Plesiotype, U. S. National Museum No. 85552.

AMPHISSITES MISERI Harlton, n. sp.

Plate 6, figure 7

Carapace subquadrate in lateral view; cardinal angles obtuse, hinge-line depressed straight; end well rounded; margin narrow, smooth; marginal frill with a single row of reticulations on its ventral side extending upward to both cardinal angles; inner frill very pronounced, running from angle to angle, paralleling the outer frill and is separated by three or four reticulations; at the antero-ventral portion four or five reticulations are present, at which portion the frill is most conspicuous; surface exhibiting three prominent nodes; anterior node large, posterior ridge-like node less conspicuous, both extending down nearly to the inner marginal frill and paralleling it in a shelf-like elevation. Median node very conspicuous, central; kirkbyian pit on the antero-ventral side of the median node. Surface with beautiful, large reticulations in parallel rows. Length, 0.92 mm.; height, 0.58 mm.; thickness, 0.58 mm.

This species is named for Hugh D. Miser.

Johns Valley shale, southern Oklahoma, loc. 10. Holotype, U. S. National Museum No. 85553.

AMPHISSITES BUSHI Harlton, n. sp.

Plate 6, figure 9*a–d*

Carapace elongate subquadrate in lateral view; ends evenly rounded, meeting the straight hinge-line with somewhat conspicuous angles; margin narrow, smooth; marginal frill with a single row of reticulations on its ventral side extending upward to both cardinal angles; surface exhibiting three very pronounced frills with coarse reticulation lines and distinct granules along the edges; the marginal frill extends upward to both cardinal angles, inner frill also extends upward to one to three reticulations below the cardinal angles and is separated on the ventral border by three or four rows of reticulations from the marginal carina, and at the antero-ventral portion by five or six reticulations; anterior and posterior nodes strongly carinate, the frill arising from the dorsal keel at a distance

of about one-fourth in from the cardinal angles and running downward to about two pits above the inner frill, paralleling it; the most prominent anterior ridge-like node extends well above the hinge-line; the inconspicuous posterior ridge-like node extends above the hinge-line slightly; the posterior node is well developed in ephebic forms, whereas in the nepionic stage only a faint development of the node may be noticed; central node very pronounced, situated slightly behind center of valve, with a conspicuous straight anterior side at the center of the valve; central pit large and depressed, semicircular, with the straight side at the anterior ventral portion of the node. Reticulations coarse. Length, 1.06 mm.; height, 0.58 mm.; thickness, 0.58 mm.

This species is named for Frederic A. Bush.

Johns Valley shale, southern Oklahoma, loc. 11. Cotype, U. S. National Museum, No. 85554.

Genus YOUNGIELLA Jones and Kirby

YOUNGIELLA WAPANUCKENSIS Harlton, n. sp.

Plate 7, figures 3*a*, *b*

Test rectangular in lateral view, greatest height about one-half the length; greatest thickness central; hinge-line straight, about three-fourths of the total length; cardinal angles distinct, ventral border straight, meeting the anterior smoothly but curving abruptly toward the cardinal angle, posterior end well rounded; free margins thickened into a conspicuous raised flange, strongest at the ends; equivalved; surface smooth. Length, 0.61 mm.; height, 0.31 mm.; thickness, 0.19 mm.

Johns Valley shale, southern Oklahoma, loc. 2. Holotype, U. S. National Museum No. 85555.

Family BAIRDIIDAE Brady and Norman

Genus BAIRDIA McCoy, 1844

BAIRDIA ARDMORENSIS Harlton

Plate 7, figure 8

Bairdia ardmorensis HARLTON, 1929, Am. Jour. Sci., vol. 18, p. 267, pl. 2, fig. 11.

Carapace rather large, subrhomboidal in outline; length about twice the height; greatest thickness between anterior and posterior third of the shell. Overlapping dorsal edge of left valve rather thick, the ventral overlap strongest near the middle, with little or no overlap at the ventro-posterior end. Dorsal border distinctly arched with dorso-anterior and posterior slope straight; ventral border nearly straight; anterior extremely rounded, more prominent above; posterior extremity acuminate. Surface evenly convex, smooth. Length, 1.29 mm.; height, 0.70 mm.; thickness, 0.44 mm.

Johns Valley shale, southern Oklahoma, loc. H-48. Plesiotype, U. S. National Museum No. 85556.

Genus BYTHOCYPRIS G. S. Brady, 1880

BYTHOCYPRIS TOMLINSONI Harlton

Plate 7, figure 9

Bythocypris tomlinsoni HARLTON, *1929*, Am. Jour. Sci., vol. 18, p. 270, pl. 2, figs. 17*a–e*.

Carapace small, nearly semicircular in outline; greatest height at posterior portion; dorsal border curved;

ventral border nearly straight, gradually curving into the rounded anterior extremity, more or less angular at the posterior; greatest thickness of valves at the posterior, left valve larger, overlapping the right on all sides. Length, 0.8 mm.; height, 0.5 mm.; thickness, 0.33 mm.

Johns Valley shale, southern Oklahoma, locs. 2, 4, 5, 10, 11, 245, 260, 211, 290, 233, 228, A-87, L-22. Plesiotype U. S. National Museum No. 85557.

HEALDIIDAE Harlton, new family

Small, mostly subovate, subtriangular or elongate, corneo-calcareous shells with thin, unequal valves, the margin of one valve overlapping the other completely; surface with one or two ridges, or posteriorly with spines or both.

Genus HEALDIA Roundy, 1926

HEALDIA CANEYENSIS Harlton

Plate 7, figure 10

Healdia caneyensis HARLTON, *1927*, Jour. Pal., vol. 1, p. 208, pl. 33, figs. *2a, b*.

Carapace sub-oval in lateral view; dorsal margin slightly curved in the anterior half, posterior half and middle gently curved. Ventral margin nearly straight, but curving gradually into the well-rounded ends. The test, viewed from above, is wedge-like, anterior rather thin and sharp, posterior end thick with well developed ridge. On the outward posterior portion of the swollen area large spines are developed. Left valve larger, overlapping the right on all sides. Surface smooth. Length of largest specimen found in the Johns Valley shale, 0.88 mm.; height, 0.61 mm.; thickness, 0.44 mm.

Johns Valley shale, southern Oklahoma, locs. 1, 2, 4, 5, 6, 10, 11, 0–38, 245, W-17, 212, 214, 272, 220, A-87, H-48, 350, 300, 100, L-22, 82, 1–2. Plesiotype, U. S. National Museum No. 85558.

HEALDIA SIMPLICISSIMA Harlton, n. sp.

Plate 7, figures *7a–c*

Carapace suboval in lateral view; greatest height just in front of center; anterior slope slightly curved, posterior straight; anterior end lower. Ventral border straight; posterior ridge spineless, very slightly convex toward the posterior end of the carapace, running nearly to the dorsal border, gradually fading out in that direction. Surface smooth. Length, 0.61 mm.; height, 0.39 mm.; thickness, 0.29 mm.

The species is best recognized by its relatively high shape, slightly curved anterior slope, and distinct posterior ridge which curves slightly dorsally.

Johns Valley shale, southern Oklahoma, loc. 10. Cotype, U. S. National Museum No. 85559.

Genus SEMINOLITES Coryell, 1928

SEMINOLITES PUSHMATAHENSIS Harlton, n. sp.

Plate 7, figures *5a, b*

Carapace semi-elliptical in lateral view; greatest height central, anterior slope straight; posterior slope straight to gently convex; ventral border straight; pronounced ventro-posterior terminal ridge situated at the ventro-posterior angle extending about two-thirds dorsally; dorso-an-

terior terminal ridge conspicuous extending ventrally to about two-thirds, rapidly fading out near the ventro-anterior portion. Length, 0.80 mm.; height, 0.38 mm.; thickness, 0.29 mm.

This interesting species with its peculiarly situated ridges makes this form easily recognizable.

Johns Valley shale, southern Oklahoma, loc. 4. Holotype, U. S. National Museum No. 85560.

SEMINOLITES KOSOMENSIS Harlton, n. sp.
Plate 7, figures 4*a*, *b*

Carapace roughly triangular in lateral view; greatest height just in front of center; anterior, and posterior slope straight; ventral border straight; the surface is ornamented with the terminal ridges, smooth. Length, 1.02 mm.; height, 0.60 mm.; thickness, 0.44.

Johns Valley shale, southern Oklahoma, loc. 4. Holotype, U. S. National Museum No. 85561.

SEMINOLITES PERFORATUS Harlton, n. sp.
Plate 7, figures 6*a–c*

Carapace suboval in lateral view; greatest height just in front of center, ventral border straight; anterior slope curved, posterior straight to gently curved; posterior ridge elevated, with well developed spines at the outward dorso- and ventro-posterior ends; in front of the ridge distinct circular reticulations are developed, usually four in nepionic and five in ephebic forms; at the anterior portion a terminal ridge with circular reticulation is well developed in ephebic forms; this terminal ridge is scarcely developed in nepionic forms. The surface of shell is ornamented by numerous circular reticulations increasing in number with age. Length, 0.73 mm.; height, 0.40 mm.; thickness, 0.31 mm.

Johns Valley shale, southern Oklahoma, loc. 6. Cotype, U. S. National Museum No. 85562.

Genus CAVELLINA Coryell, 1928

CAVELLINA SUBOVATA Coryell
Plate 7, figure 11

Cavellina subovata CORYELL, *1928*, Jour. Pal., vol. 2, p. 93, pl. 11, fig. 8.

Small, subovate, inequivalved ostracode; dorsal margin broadly arched; greatest height near the middle and equal to one-half the length; anterior margin broadly rounded; posterior margin showing only faintly the acute curvature; ventral contact straight; right valve extends beyond the edge of the left valve all around, appearing to overlap most on the dorsal and ventral margin and somewhat less along the posterior margin; the anterior edge of the left valve is raised from the right, forming a channel; the surface of each valve smooth; the greatest thickness near the posterior margin; the dorsal view cuneate, most compressed near the hinge margin; the posterior position within each valve is conspicuous, thick, and crosses the valve diagonally from the dorsal margin to the anterior ventral edge; the tubercle is present; other thickenings of the valves upon the inside are inconspicuous. Length, 1.27 mm.; height, 0.81 mm.

Johns Valley shale, southern Oklahoma, locs. 5, H-48. Plesiotype U. S. National Museum No. 85563.

CAVELLINA LATA Coryell

Plate 7, figure 12

Cavellina lata CORYELL, *1928*, Jour. Pal., vol. 2, p. 94, pl. 11, fig. 11.

Small, very broad, flattened subovate, inequivalved ostracode; dorsal margin arched; ventral contact somewhat convex; anterior broadly rounded; ventral half of posterior margin more broadly rounded than the dorsal; posterior and anterior partitions present within the valves; dorsal and ventral extensions of the right valve beyond the left narrow; anterior margin channelled; greatest thickness near the most narrowly curved part of the posterior contact; greatest height near the middle. Length, 1.27 mm.; height, 0.81 mm.

Johns Valley shale, southern Oklahoma, locs. 2–53, P-17, 233, P-69, H-48. Plesiotype, U. S. National Museum No. 85564.

REGISTER OF LOCALITIES

0–38 S line of sec. 14, T 2S., R 11E., ½ mile SE of Atoka near Choctaw fault
245 NE¼ SE¼ NW¼, sec. 36, T 1S, R 12E.
260 SW cor. sec. 2, T 2S, R 13E. Patapo Creek
2–53 SW¼ NE¼ sec. 31, T 2N, R 13E. Limestone Gap; middle of Wapanucka limestone
W–17 SE cor. sec. 1, T 1N, R 13E, ½ mile SE of Wesley
210 SW¼ NW¼ SE¼, sec. 1, T 1N, R 13E. Just south of Wesley
211 SW¼ SE¼ sec. 1, T 1N, R 13E. ½ mile south of Wesley
212 NW¼ SE¼ SE¼ sec. 36, T 2N, R 13E, NE of Wesley
P–17 Center sec. 10, T 2N, R 13E. Shale in Wapanucka limestone in Wards Creek; Gap in limestone ridge, ½ mile south of Reynolds
214 NE¼ NE¼ sec. 1, T 2N, R 13E. Shale in Wapanucka
290 NE¼ sec. 20, T 3S, R 14E. In creek
272 Near NE¼ SW¼ sec. 32, T 2S, R 14E. In gulch leading to McGee Creek
240 NE¼ NW¼ NW¼ sec. 19, T 1S, R 14E
233 SW cor. NW¼ NE¼ sec. 32, T 2N, R 15E.
232 SW cor. NW¼ NW¼, sec. 28, T 2N, R 15E
231 NW cor. SE¼, sec. 16, T 2N, R 15E.
P–69 C. S. L. sec. 8, T 3N, R 15E. 2 miles southeast of Blanco Choctaw fault, shale under Wapanucka
225 NE¼ SW¼ SW¼ sec. 5, T 2N, R 16E
221 NE¼ SE¼ SW¼ sec. 26, T 3N, R 16E On Savage highway, Windingstair Mountains
220 SE¼ NE¼ NW¼ sec. 26, T 3N, R 16E, On Savage highway, Windingstair Mountains
2–31 Center W½ sec 26, T 3N, R 16E. Summit of Windingstair Mountains
A–87 NE cor. sec. 20, T 3N, R 16E, Allen's locality
H–48 Center N½ sec. 18, T 4N, R 17E. Hartshorne limestone quarry, shale below Wapanucka limestone, base of quarry
350 SW¼ NE¼ NW¼ sec. 16, T 3N, R 18E
Y 10 Center W line sec. 18, T 3N, R 19E
300 NW cor. SW¼, NE¼ sec. 32, T 4N, R 20E. Cooper hollow
153 SW¼ NW¼ NE¼ sec. 22, T 4N, R 21E. In creek
121 NE¼ NW¼ sec. 17, T 4N, R 21E. Near Peachland Creek
100 NE¼ NE¼ sec. 18, T 4N, R 21E., About 850 paces west of Peachland Creek
50 SW¼ NW¼ NW¼ sec. 28, T 4N, R 22E. Lamberson spur on Frisco R.R. about 3/10 mile east of quarry on south side of main creek just up a tributary stream about 50 feet.
L–37 NW¼ SE¼ sec. 29, T 4N, R22E, Lower part of upper boulder. Lamberson spur on Frisco R. R.
L–22 NW¼ SE¼ sec. 29, T 4N, R 22E. Lamberson spur on Frisco R. R.
82 Junction of secs. 17, 18, 19 and 20, T 4N, R 22E, Near Compton
87 SE cor. NW¼ SE¼ sec. 18, T 4N, R 22E, in cut ½ mile north of Compton on Frisco R.R. across Windingstair Mountains
S 108 S½ NE¼ sec. 16, T 3N, R 16E, K.C.S. R.R. cut 4 miles southeast of Stapp (Thomasville on topographic map)
1–2 SW¼ NE¼ sec. 12, T 3N, R 25E, ½ mile southwest of Stapp

JOHNS VALLEY Localities

1. C.W.L. sec. 3, T 1S, R 16E. Shale from 35′ hand dug well at J. W. Breshear house
2. NE¼ SE¼ sec. 4, T 1S, R 16E. Southwest of farm-house along W. line of sec. 3

3. SE¼ NW¼ NE¼ sec. 4, T 1S, R 16E. Head of stream
4. NE¼ SW¼ sec. 4, T 1S, R 16E. Between boulder locality Nos. 1 and 2
5. NE¼ SE¼ SW¼ sec. 4, T 1S, R 16E North of Baskett farm-house, from 60 ft. hand-dug well
6. NE¼ SW¼ NW¼ sec. 4, T 1S, R 16E Northwest of boulder locality No. 2
7. SW cor. sec. 4, T 1S, R 16E. In creek bottom
8. NE¼ SE¼ NE¼ sec. 8, T 1S, R 16E North of boulder locality No. 4
9. C.N.L. NW¼ NE¼ sec. 10, T 1S, R 16E. Along north line of section
10. C.S.L. NE¼ SE¼ sec. 10, T 1S, R 16E, East of boulder locality No. 6
11. SE¼ NW¼ sec. 33, T 1N, R 16E. Head of stream

A–1. NW cor. SE¼ sec. 4, T 1S, R 16E. 1,000 ft. northwest of Baskett house, south side of creek. Auger drill hole from 3 to 7 feet

JOURNAL OF PALEONTOLOGY, VOL. 7, NO. 1, PP. 30–58, PLS. 8–12, MARCH, 1933

THE GASTROPODS OF THE ST. LOUIS, MISSOURI, PENNSYLVANIAN OUTLIER: V. THE TROCHO-TURBINIDAE

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ABSTRACT

This paper deals with those gastropods that may be referred to the admittedly composite family Trocho-turbinidae. The character commonly relied upon to differentiate the Turbinidae from the Trochidae, i.e., the presence of a calcareous operculum in the former, is discussed. It is suggested that a classification based on this character alone may well be unnatural and it is certainly difficult if not impossible to apply to fossil forms. Hence it is thought expedient tentatively to use the name Trocho-turbinidae for gastropods without a pleurotomarian slit or slit-band but which give evidence of having possessed a nacreous, inner shell layer. Certain morphological terms are discussed and an attempt made to clarify them.

The genus *Strophostylus* Hall is discussed on the basis of a restudy of Hall's type specimens of the genotype, *S. elegans* Hall. It is shown that the name *Strophostylus* must be applied to the forms for which the name *Callonema* Hall (not Conrad) was coined and not as Hall obviously intended to platyceratid forms with a twisted columella. A new sub-genus of *Strophostylus*, *Anematina* Knight, is established with *Holopea proutana* Hall as the type. *Glyptobasis* de Koninck (not Wallengren) and *Flemingia* de Koninck (not Johnston) are referred to synonymy with *Anematina*, at least until a restudy of type material shall show that they should be revived under new and valid names.

The genera *Microdoma* Meek and Worthen, *Yunnania* Mansuy, *Anomphalus* Meek and Worthen and *Angyomphalus* Cossmann are discussed. It is shown that *Tuberculopleura* Jakolew is a synonym of *Microdoma*, that *Yunnania* Mansuy must replace *Portlockia* de Koninck (not M'Coy), and that *Rotellina* de Koninck, *Pycnomphalus* Lindström, and *Antirotella* Cossmann are synonyms of *Anomphalus* Meek and Worthen. It is suggested that *Anomphalus* is very close to *Isonema* Meek and Worthen.

Three new names are proposed for Paleozoic trochid genera, *Rhabdotocochlis*, genotype *R. rugata* Knight, n. sp., *Araeonema*, genotype *A. virgatum* Knight, n. sp. and *Eucochlis*, genotype *E. perminuta* Knight, n. sp.

The species from the St. Louis Pennsylvanian outlier described, or redescribed in detail are: *Strophostylus* (*Anematina*) *minutissimus* Knight, n. sp., *Microdoma conicum* Meek and Worthen, *Yunnania subsinuata* (Meek and Worthen), *Rhabdotocochlis rugata* Knight, n. sp., *Araeonema virgatum* Knight, n. sp., *A.? sp.*, *Eucochlis perminuta* Knight, n. sp., *Anomphalus umbilicatus* Knight, n. sp. and *Angyomphalus minutus* (Sayre).

A "turbinid" operculum which may be that of *Y. subsinuata* (Meek and Worthen) is also described.

A correction to a previous paper of the series is carried in an appendix. It is shown that the name *Aclisina* de Koninck, owing to an early designation of *A. striatula* (de Koninck) as genotype, must be applied to the Murchisonid sub-genus for which Mrs. Longstaff (Miss Donald) proposed the name *Aclisoides*. The genus to which the name *Aclisina* has commonly been applied thus being nameless, the name *Donaldina* Knight is proposed for it, with *D. grantonensis* (Donald) as the genotype.

INTRODUCTION

This, the fifth paper of a series on the gastropods of the St. Louis, Pennsylvanian outlier (3), has to deal with some eight species that will be

referred to an admittedly composite group which is arbitrarily given family rank. To this group will be applied the equally composite and nomenclatorially invalid name Trocho-turbinidae, first used by Koken and later by Perner (2b, p. 164). This name by its very nature reflects the composite and tentative character of the group it designates. It must not be supposed from the foregoing that the Trocho-turbinidae as here constituted is made up of wholly unrelated genera. Indeed, they all seem to be interrelated, but so complexly that it is not feasible to attempt to untangle the phyletic lines and to subdivide it into its smaller, more compact groups or families in a study which must of necessity be limited to the few genera that are met in treating the species found in the St. Louis Pennsylvanian outlier.

The genera commonly referred to the Trochidae and the Turbinidae make up a large part of the composite group. These two families are to be differentiated according to current opinion of conchologists on the presence or absence of a single character, a character that is known to have little significance in smaller and more compact groups (such as the Naticidae for instance) and which in all probability has as little importance in the group we are considering. This character is simply the presence or absence of a secondary layer of calcareous matter secreted by the foot on the outer surface of the basically corneous operculum. Even considering the soft parts, and the radulae, which are of course available to students of the Recent forms, I have been able to find recorded no greater difference between trochid and turbinid genera than between genera included in one or the other family. And, on the other hand, genera placed by virtue of the presence or absence of the opercular calcareous layer in different families seem to have more in common than they do with their supposedly closer relatives. Of course, if the Trochidae and Turbinidae as restricted are not natural groups, it is not to be wondered at that insuperable difficulties arise in assigning Paleozoic genera to one family or the other.

Even granting for the moment the validity of the calcareous operculum as a criterion of family rank, the failure to find a calcareous operculum in fossil forms is negative evidence only. Opercula do not commonly retain their position after the decomposition of the soft parts, and the assignment of any operculum found free to any given species, genus, or in some instances even to a given family is exceedingly dangerous unless examples with opercula in place are known. Hence attempts to place Paleozoic genera in these two families on the basis of opercula are for the most part doomed to failure because of the very exigencies of preservation.

Cossmann attempted to differentiate the Turbinidae from the Trochidae in the absence of opercula by the inclination of the columeller lip which he thought should match that of the outer lip in the Turbinidae but not in the Trochidae, (1, vol. 11, p.

104, 168). I cannot recognize in this criterion, however, any real value. Cossmann (loc. cit.) supposed that the inclination of the sides of the aperture in the Turbinidae is due to the close application to the lip of the rigid calcareous operculum whereas this is not required by the flexible corneous operculum of the Trochidae. We wonder if Cossmann had never observed that the opercula of living Trochids and Turbinids do not rest on the edges of the aperture like a lid on a box or even on the shelf-like shoulder occurring within the aperture of some species. When such a gastropod is fully withdrawn into its shell the operculum, even a large calcareous one, may be drawn within the apertural margins for almost a quarter of a whorl, and has no mechanical connection with those margins whatever.

The most complete treatment of Paleozoic forms is to be found in Perner's monumental work on the gastropods of the early Paleozoic of Czechoslovakia (2). Perner, with little evidence, places some of the forms which seem to belong here in post-Paleozoic families such as the Epitoniidae (=Scalariidae), Architectonicidae (=Solariidae) and Littorinidae which otherwise have no representatives before the Mesozoic.

As here used the Trocho-turbinidae will include most of the genera listed in the sixth German edition of Zittel's *Grundzüge der Paläontologie* under the Turbinidae, Trochonematidae, Trochidae and Umboniidae, together with some of those listed under the Solariidae (=Architectonicidae), the Littorinidae and the Scalariidae (=Epitoniidae). The family may be broadly defined as including turbinate, discoidal, turreted, or pyramidal gastropods with subcircular apertures, without a slit or slitband in the outer lip, and with a shell that is distinctly double-layered. The inner shell layer is known to be nacreous in Recent and many fossil forms and is believed to have been so in all of them. I know of no case of the preservation of the true nacreous luster in any Paleozoic examples but it is in some cases easy to demonstrate the presence of two different shell layers of very different structure, the inner of which was in all probability nacreous during life. Of course even the identification of the double layering is dependent to a large extent on the state of preservation, for many superficially perfectly preserved specimens, such as those from the *Stringocephalus* beds at Paffrath for example, are too coarsely recrystallized internally to preserve any traces of shell structure. Yet I have found examples of a number of genera which are preserved so favorably that thin or polished sections of the shell do show recognizable double layering.

While it is not safe to conclude from so few examples as I have been able to examine that all the genera in question do in fact possess such double layering it seems a reasonable working assumption, subject to change as our knowledge increases. The editions of Zittel's *Grundzüge* and the English edition edited by Dr. Eastman have made the same as-

sumption for the Turbinidae, Trochonematidae and Trochidae, though on what grounds it was based for the Paleozoic genera I do not know. The literature throws very little light on the subject, probably because workers were not searching for double layering as a clue to the matter but only for actual nacreous luster itself. It seems too much to expect that the nacreous luster of Paleozoic specimens should be preserved. My own material, in which the double layering of the shells of some species can be seen with great clearness (Pl. 12, figs. 6*a*, *b*) and which are often well enough preserved to show color patterns, in no instance shows any signs of true nacreous luster.

The Trocho-turbinidae may have still a third shelly layer within the true nacreous layer. This, however, is not a primary shell structure but a secondary deposit, used to fill the earlier whorls partially or wholly if and as they are abandoned. I have not seen this secondary deposit in any fossil trochids, though it is very evident in some Recent species that I have sectioned. This secondary layer is homologous with the similar secondary layer in some of the Loxonematidae, Streptacididae and Subulitidae (3a, b, c), in which there is no primary double layering and no nacreous layer.

Before proceeding with the discussion of the genera of the Trochidae which are represented in my collections from the Pennsylvanian outlier at St. Louis it will be well to discuss and clarify certain morphological terms and concepts.

The term *callus*, so widely used in the literature for any thickened deposit of shell material in or about the aperture of gastropods has been discussed in a previous paper of this series (3c, p. 179–180) and limited in its application to the thick deposit that extends out beyond the inner lip and partially or completely fills the umbilicus, as in the genus *Neverita*, or, to choose an example closer to the group under discussion, as in *Umbonium*. A callus, in the limited sense here employed, generates a *funicle*, a ridgelike thickening of the inner lip outside of the aperture proper, as growth proceeds. In some shells in which the base is not flattened and the anterior margin of the aperture extends considerably beyond the base, the callus is placed relatively high on the inner lip and the funicle lies entirely within the umbilicus, as in *Neverita*, for example. In others of a more lenticular shape and with a relatively flattened base, the callus is placed closer to the anterior margin and the funicle assumes a circumumbilical position, as in *Pycnomphalus obesus* Lindström (see Plate 11, fig. 3*a*, *c*). The callus may thus be small and generate only a small funicle, circum-umbilical or intra-umbilical in position depending on the shape of the shell, or it may be so large that the funicle completely fills the umbilicus, or even, as in *Umbonium*, overlaps onto the opposite segment of the funicle itself and onto the surrounding base. In the latter case the umbilicus is commonly said to be filled with callus, or even more loosely, the shell may be said to be

	Proposed terminology	*Abandoned terminology*
For shells with:		
Open umbilicus	phaneromphalous[1]	perforate
Partially plugged umbilicus	hemiomphalous	
Completely plugged umbilicus	cryptomphalous	imperforate
No umbilicus	anomphalous	

without an umbilicus, or imperforate.

The term *perforate* and its antonym, *imperforate*, have a precision about them as applied to gastropod shells that has served to recommend them and to bring them into general use. They have, however, one fatal fault, the precision has to do with what may be called a *physical* rather than with a *morphological* character. A shell with no umbilicus at all and a shell with a callus-plugged umbilicus are both quite "imperforate," while a shell with an open umbilicus and one with an umbilicus partially filled with callus are both "perforate." Hence I propose to abandon both these terms as likely to cause continued confusion and suggest the four following descriptive terms instead, which may be applied to the shell itself, to the base of the shell or to the columella just as perforate and imperforate have been applied.

It must be borne in mind that a phaneromphalous shell may have a very wide umbilicus as in *Euomphalus* or *Architectonica* or a very narrow umbilicus as in *Microdoma*, that a shell may belong in one category at one growth stage and in another at a different growth stage, and further, that closely related species may appear in different categories.

All degrees of development of the callus and funicle may and often do occur in series of species that seemingly cannot be separated into valid phyletic series or genera on the basis of the degree of development of this character alone, and we thus may have properly in the same genus species with a rather wide, open umbilicus and with an umbilicus filled to overflowing with callus. Indeed, as will be shown later, we may find both conditions at different ontogenetic stages of individuals of a single species.

[1] All of these terms are derived from the stem of the Greek word ὀμφαλος (signifying navel, umbilicus) with the English adjective termination "ous" and compounded with one of the following from the Greek; φανερός (=open, manifest), ἡμί (=half), κρυπτός (=hidden, secret) and the negative prefix, *alpha privativum*.

GENERIC DISCUSSIONS AND DIAGNOSES

GENUS STROPHOSTYLUS HALL

The name *Strophostylus* was proposed by Hall in 1859 (7, p. 303) for certain Paleozoic platyceratid shells which possess "a peculiar form of columella, which is more or less distinctly twisted and coiled." Thanks to Hall's well expressed intentions and to the excellent, but unnamed, text figures of specimens of *Strophostylus tranversus* Hall and *S. andrewsi* Hall that accompany the generic diagnosis, the term has since been used for such shells. This usage has been further strengthened by Keyes' discussions of 1890 and the designation at the same time of *S. andrewsi* Hall as genotype (8). Unfortunately for cur-

rent stability and for the use of the name in accordance with its author's intentions, S. A. Miller had in 1889 designated (9, p. 427) *S. elegans* Hall as the genotype and this designation is not only technically valid but it compels the use of the name for an entirely different group than was intended.[2]

Examination of the type specimens of *S. elegans* shows conclusively certain characters that compel its inclusion in that group of shells generically related to *Loxonema bellatulum* Hall which subsequently became the genotype of the genus *Callonema* Hall.

Hall's original description and figures of *S. elegans* fail to show its characters well, but through the courtesy of Dr. C. A. Reeds, I have recently had the privilege of examining the types of this species preserved in the Hall Collection at the American Museum of Natural History. One of the four specimens which I designate the holotype, (Amer. Mus. No. 2576/3), the original of Hall's fig. 1c (7, plate 55), shows the base nicely, though the aperture is somewhat obscured by matrix. This specimen is refigured from photographs as Plate 8, fig. 3*a*, *b*, of this paper. The base shows an umbilicus of the same character as that of *Callonema bellatulum* Hall (see pl. 8, figs. 4*a*, *b*) with which it also shares its general form, type of ornamentation and characters of the outer lip. There can be little question that the two species are congeneric and that *Callonema* Hall 1879 (10, p. 50) an homonym of *Callonema* Conrad 1875 (11, p. 12) is therefore a synonym of *Strophostylus* Hall 1859.* The other species included by Hall under *Strophostylus* such as *S. transversus* Hall and *S. andrewsi* Hall and various of the species referred to the genus by later authors are thus left without generic assignment and may well be left tentatively in the genus *Diaphorostoma* Fischer of which *Strophostylus* as heretofore conceived has been considered a synonym by some.

The genus *Callonema* Hall, to which the name *Strophostylus* must now be applied, as conceived by Hall, included only species with the fine, transverse lirae, or fasciculated growth lines such as occur in *S. elegans* or *S. bellatulus* and on other Devonian species, but there occur in Carboniferous strata certain species that seem to agree generically with these Devonian forms in every respect except that they have no ornamentation. One such species is *Holopea proutana* Hall (see pl. 8, figs. 2*a*, *b*) from the Salem (Spergen) limestone of Indiana (12, p. 30) and another from the Pennsylvanian will be more specifically dealt with in this paper. Whitfield, in discussing *Holopea proutana*, (13, p. 72) questioned the propriety of referring it to the genus *Holopea* and was the first to suggest that it might be more properly referable to *Callonema*, but in the end he did not

[2] This is an excellent example of the harm that can be, and all too frequently is done, under the absurd "first species rule" for the selection of genotypes.

* The name *Elasmonema* was proposed by Fisher in 1887 (*Manual Conch.*, p. 778) for *Callonema* Hall, preoccupied, and if the subjective synonymy of *Callonema* under *Strophostylus* is not accepted, must be used instead of *Callonema*.

change Hall's original reference except to insert the name *Callonema* with a query and in a parenthesis in his citation of Hall's original description. Through the courtesy of Dr. Reeds, I have been permitted to study the type specimens (see pl. 8, fig. 4*a*, *b*) of *Callonema bellatulum* (Hall). I have also had available in the Peabody Museum at Yale University numerous topotype specimens of *Holopea proutana* Hall.[3] With the types before one the essential relationship of the beautifully lirate Devonian species and the almost entirely smooth Mississippian one is seemingly evident. And yet the presence or absence of lirae seems to be too important to pass over entirely, particularly as it appears to have stratigraphic significance. Hence it is natural to express the relationship by dividing *Strophostylus* (= *Callonema* Hall) into two subgenera, *Strophostylus* (*s.s.*) with *S. elegans* Hall as genotype, and a new subgenus with *Holopea proutana* Hall as genotype. For the latter subgenus I propose the name *Anematina* Knight, new subgenus, the name being derived from the stem of the Greek word *νῆμα,-ατος*, a thread, prefixed by *alpha Privativum* signifying want or absence of, and with the suffix, ina.

Diagnosis of genus Strophostylus *Hall, emend Knight*

Subturbinate, phaneromphalous gastropods with flatly rounded, sometimes slightly pendant whorl profile; outer lip thin, without sinuosity and with moderate backward obliquity; aperture entire; inner lip simple; inductura thin; nucleus simple and smooth.

Genotype *S. elegans* (Hall)

Subgenus Strophostylus *Hall* (*sensu stricto*)

In addition to the characters of the genus, the nomenclatorially typical subgenus displays fine but distinct transverse lirae. The umbilicus is moderately wide and in some instances the base turns rather sharply into it. Some forms show an obtusely angulated shoulder on the whorls just below the suture. The type is the same as for the genus. This subgenus seems to be confined to the Devonian though it may be represented in the Silurian.

Subgenus Anematina *Knight, n. subgenus*

The species of this subgenus differ from those of the typical subgenus in that they consist of forms without ornamentation (or with revolving ornamentation on the base) and with very narrow umbilici.

The genotype is *S.* (*A.*) *proutanus* (Hall) (= *Holopea proutana* Hall)

This subgenus seems to be confined to the Carboniferous.

Hall's statement that *S.* (*A.*) *proutanus* is imperforate is erroneous, for sections of topotype specimens show the columella to be narrowly phaneromphalous for its entire length, though the umbilicus is so narrow as to be discernible from the exterior only with difficulty when it is filled with matrix.

[3] It seems unnecessary to argue the point that *Holopea proutana* is not a proper *Holopea*.

To the subgenus *Anematina* I refer not only the genotype but *S.* (*A.*) *marshalli* (Roundy) 1914 (14, p. 447) described as *Glyptobasis* and somewhat doubtfully *S.* (*A.*) *micula* (Girty) 1909 (15, p. 43) described as *Macrocheilus* (?).

Two genera described by de Koninck in 1881 approach rather closely to *Anematina*. These are *Flemingia* (4, p. 93) and *Glyptobasis* (4, p. 92). However, the characters of neither genus are very clear so it is perhaps fortunate that both names are preoccupied and the genera can be allowed to lapse into the synonymy of *Anematina* until such time as type material can be restudied. *Flemingia* was used in 1846 by Johnston for vermes and *Glyptobasis* by Wallengren in 1871 for insects.

Perneritrochus Cossmann 1909 (16), approaches *Strophostylus* somewhat closely. It is to be differentiated by a sharply carinate basal angle and by a wider umbilicus. The ornamentation of *Perneritrochus venalis* (Barrande), the genotype, reminds one strongly of that of *Strophostylus bellatulus* (Hall) and the shape itself is not so very different. *Umbotrochus* Perner 1907 (2, b, p. 239) seems to approach even more closely, but this genus is based on a single species represented by a single very imperfect specimen and is therefore very imperfectly known. It is quite within the bounds of possibility that the three genera are identical or at most to be differentiated as subgenera. Yet until *Perneritrochus* and *Umbotrochus* are themselves better known and the limits of variation within them have been studied it seems best to consider them distinct.

Discorditrochus Cossmann 1918 (1, vol. 11, p. 272), with *Trochus mollis* Lindström as genotype, also approaches very closely to *Strophostylus* but is to be differentiated by a subangular periphery and flattened base.

Isonema Meek and Worthen (1865) has by some been considered very close to, if not synonymous with *Callonema*, but, as is shown in another part of this paper, it is quite distinct.

As stated above, *Strophostylus* (*s.s.*) seems to be confined to the Devonian while the subgenus *Anematina* is known only in the Carboniferous, though it, like most Carboniferous genera, may be looked for in the Permian.

GENUS MICRODOMA MEEK AND WORTHEN, 1866 (5b, p. 269)

Shell elongate conical; whorl profile flat; base roundly flattened, sutures shallow; axis narrowly phaneromphalous; inner lip reflexed; inductura thin; outer lip sharp, margin with rather marked backward obliquity; double shell-layers clearly marked, the inner one almost certainly nacreous in life; nucleus simple, dextral, turbinate; nepionic ornamentation well marked growth lines or fine lirae; ornamentation at neanic stages (of the genotype at least) transverse costae which are at ephebic stages broken up into nodes by the superposition of revolving furrows on the costae; ornamentation at gerontic stages obscure.

Genotype by monotypy, *M. conicum* Meek and Worthen.

The genus *Microdoma* is easily distinguished by its form and its ornamentation which, in combination, are very distinctive. The range of the genus is Mississippian to Permian.

It is interesting to note the great similarity of both the form and the ornamentation of the genotype at nepionic stages to the adults of *Strophostylus* (*s.s.*) and it is suggested that *Microdoma* is derived out of *Strophostylus* as here emended.

Tuberculopleura Jakowlew 1903 (20, p. 121) genotype by subsequent designation *T. kulogorae* Jakowlew (1, vol. 8, p. 94) is clearly a synonym of *Microdoma* Meek and Worthen.

GENUS YUNNANIA MANSUY, 1912

In 1881 de Koninck proposed the name *Portlockia* for a rather heterogeneous group of shells many of which might have been previously referred to *Cyclonema* Hall (4, p. 81). Though de Koninck failed to select a genotype the deficiency was remedied by Cossmann who designated *Turbo sub-pygmaeus* d'Orbigny in 1915 (= *T. pygmaeus* de Koninck 1843, not Deshayes 1832) (1, vol. 10, p. 15). Unfortunately, however, the name *Portlockia* was preoccupied by M'Coy in 1846 for a genus of trilobites and hence de Koninck's name must be suppressed as an homonym.

In 1912 Mansuy proposed the name *Yunnania* (19, p. 103) for two Permo-Carboniferous species from Indo-China which are seemingly congeneric with *P. sub-pygmaeus* d'Orbigny, and Cossmann designated *Y. termieri* Mansuy as the genotype (1, vol. 11, p. 327) (See pl. 10, fig. 3*a*, *b*). Thus the name *Yunnania* must replace *Portlockia*. Mansuy says that *Y. termieri* is anomphalous (imperforate) but he does not give any indication of having sectioned a specimen and it is sometimes almost impossible to discover a minute umbilicus in fossil species except by study of a section. Thus *Portlockia sub-pygmaeus* was described as anomphalous by de Koninck but Cossmann later showed it to be minutely phaneromphalous. In any case the difference between a minute umbilicus and none at all is not necessarily a difference of generic rank, and it is common to find phaneromphalous and anomphalous species properly placed in the same genus amongst the Trocho-turbinidae.

Yunnania may be defined as follows: Small, turbinate gastropods with moderately deep sutures, rounded whorl profile, rounded base and with ornamentation composed of relatively few, rather sharp, revolving costae, separated by widely rounded furrows. Faint, transverse costules may be superimposed upon the upper revolving costae but do not extend down across the whorls. The columella may be minutely phaneromphalous. The aperture is rounded to suboval, the outer lip somewhat oblique, and the inner lip slightly reflexed. The shell is composed of two distinct layers of which the inner was presumably nacreous in life. The neucleus is simple, dextral and unornamented.

Yunnania has much the same general type of ornamentation as several Paleozoic genera and, though on a

superficial examination might be confused with them, is easily distinguished. Thus *Poleumita* Clarke and Ruedemann 1903, (=*Polytropis* de Koninck 1881, not Sandberger 1874, =*Polytropina* Donald 1905), has for its genotype *Euomphalus discors* Sowerby, a species with an euomphalid shape, rather wide umbilicus, slightly thickened inner lip and almost lamellar transverse growth lines. Indeed the two genera have, in spite of their superficial resemblance, only two features in common, the shary, widely spaced revolving costae and a double-layered shell.

Horiostoma Munier-Chalmas 1876, genotype *H. barrandei*, is too little known to deserve consideration except on the basis of new material and is possibly synonymous with *Poleumita*. *Trochonema* Salter, 1859, genotype *Pleurotomaria umbilicata* Hall, and *Eunema* Salter, 1859 genotype *E. strigillata* Salter, the former with a moderately wide umbilicus and the latter with a narrow one or none at all, are to be differentiated from *Yunnania* by very widely spaced revolving costae and a funicle surrounding the umbilical region. *Cyclonema* Hall 1852, genotype *Pleurotomaria bilix* Conrad, hardly needs comparison as its peculiarly flattened columellar lip and fine revolving lirae are sufficient to distinguish it at a glance. *Rhabdotocochlis* Knight, described herein, has a thicker shell and a peculiarly thickened and excavated inner lip.

The range of *Yunnania* seems to be from Devonian to Permian.

I know only two American Carboniferous species, besides *Y. subsinuata*, that seem to be referable to the genus. These are *Y. leavenworthana* (Hall) and *Y. subangulata* (Hall), both originally referred to *Pleurotomaria* and subsequently to *Cyclonema*.

Genus Rhabdotocochlis Knight, n. gen.

Small, sub-turbinate to globular gastropods with rather shallow sutures, rounded whorl profile, rounded base, and ornamentation composed of relatively few, sharply raised, revolving costae separated by rounded furrows. The columella is minutely perforate. The aperture is circular within, the outer lip non-sinuate and quite oblique, and the inner lip with a wide flattened area. The shell is quite thick, and particularly so at the antero-umbilical margins of the aperture; it is composed of two layers the inner of which was probably nacreous in life. A distinct groove is hollowed out of the inner edges of the columella and free margins of the aperture forming a shelf-like area within. The nucleus is simple, dextral and smooth.

Genotype *R. rugata*
Knight n. sp.

The name is derived from the Greek ῥαβδωτός (=fluted, striped) and κοχλίς (=small snail).

The very distinctive apertural characters of the genus seem to be sufficient to differentiate it from any Paleozoic genus with similar ornamentation.

As far as is known the genus is confined to the Pennsylvanian, and

is represented only by the genotype species. It resembles very closely the Tertiary and Recent genus *Leptothyra* Carpenter.

GENUS ARAEONEMA KNIGHT, N. GEN.

Small, sub-turbinate gastropods with sutures of moderate depth, rounded whorl profile, rounded base, and ornamentation composed of fine rounded revolving threads sometimes of unequal strength. The columella is minutely phaneromphalous. The whorl section is distinctly sub-quadrangular. The aperture is sub-circular; the outer lip thin, non sinuate and slightly oblique, and the inner lip is thin and without a callus. The shell is thin and composed of two layers, the inner of which was probably nacreous in life. The nucleus is simple, dextral and smooth.

GENOTYPE ARAEONEMA VIRGATUM KNIGHT, N. SP.

The name is derived from the Greek ἀραιός (=thin, weak, narrow) and νῆμα (=thread).

The thin shell and sub-quadrangular whorl section in combination with the minutely phaneromphalous columella and fine revolving lirae seem to distinguish the genus from any known to me. The species described herein are the only known species and are confined to the Pennsylvanian.

GENUS EUCOCHLIS KNIGHT, N. GEN.

There occurs among my smaller gastropods a number of specimens that seem to be adults of a species of tiny forms that is generically very difficult to place. In a very general way they resemble young specimens of some of *Palaeostylus* Mansuy (17, p. 48) (*sensu lato*, =*Pseudozygopleura* Knight *sensu lato*) (3d, p. 202) but the nepionic whorls are entirely different. Furthermore, there is a suggestion of a double-layering to their shells. Therefore, they seem to be more at home among the Trochoturbinidae than the Loxonematidae and it is with the Trocho-turbinidae that I am placing them, though with some hesitation. It is with some hesitation also that I erect for the species to be founded on these specimens a new genus, *Eucochlis*. Yet this species is a valid one and would seemingly be out of place in any genus with which I am familiar. It is possible that *Hemizyga* (*Hemizyga*) *illineata* Knight should find a place together with the genotype in *Eucochlis* rather than in *Hemizyga* to which it was referred with some doubt, though its thickened columellar inductura seems to exclude it.

Eucochlis may be defined as follows: Minute, sub-turbinate gastropods with moderately deep sutures, a somewhat pendent whorl profile, rounded anomphalous base, and ornamentation consisting of low transverse costae, which, following the course of the outer lip, are somewhat oblique. The whorl section is subcircular, and the shell rather thick with a suggestion of double layering, though this latter feature is not entirely clear in the only specimen of the genotype species sectioned. The aperture is sub-circular and the outer

lip thin and hardly sinuate. The inner lip is sharp and without any thickening. The nucleus is dextral and rather flatly coiled, smooth at first and not clearly set off from subsequent whorls.

Genotype, *Eucochlis perminuta* Knight, n. sp.

The name is derived from the Greek κοχλίς (=a small snail) and the prefix εὖ for emphasis.

Eucochlis is to be differentiated from *Palaeostylus* Mansuy by its nucleus and by its seemingly double-layered shell. In some respects it suggests *Sosiolytes* Gemmellaro (18, p. 83) but its whorls do not expand so rapidly, it does not have the callus of that genus and, although its growth lines seem to follow much the same course as the growth lines in *Sosiolytes*, they do not in the latter fasciculate into transverse costae.

The genus is confined to the Pennsylvanian so far as is known.

GENUS ANOMPHALUS MEEK AND WORTHEN, 1866

The Paleozoic genera having the general form of the Tertiary and Recent genus *Umbonium* might be referred to the Umboniidae Adams or very doubtfully to the Cyclostrematidae Fischer but it is thought best to hold them tentatively, at least, in the broadly conceived Trocho-turbinidae. These genera are poorly understood and include a number of synonyms. The excessive splitting has been due primarily to two causes, very imperfect knowledge of previously described genera, the erroneous evaluation of criteria, and the overstressing of differences that are of no more than specific value.

The systematist must constantly bear in mind that criteria vary in different groups. A criterion or a group of criteria that seem to lead to natural, phyletic assemblages in one group of animals may lead to entirely fallaceous conclusions in another. One cannot safely assume *a priori* that the presence or absence of a given character in two specimens is necessarily of even specific value, although a similar character is a perfectly valid criterion for higher groupings among other species. Indeed, groupings must be based on the sum total of the characters. If after the groupings are made, one character, or a combination of a few simple and obvious characters, can be chosen to serve as keys for future recognition, the work of the non-systematist is thereby much simplified; but for the systematist to approach his task with an eye only for obvious key-characters will most probably result in a classification that may have a false appearance of convenience but no phyletic significance. Such a classification will be as inconvenient in the long run as it is unnatural.

There have been proposed, to my knowledge, some nine names for Paleozoic rotelliform gastropods, the genotypes of which suggest quite close affinities among themselves. Two of these nine names, *Umbotropis* Perner, 1903 (2a, pl. 42; 2b, p. 259) and *Umbospira* Perner, 1903 (2a, pl. 42; 2b, p. 257) are based on what appear to be insufficiently known genotype species and hence

must remain *genera inquirenda* for the present; three names which will be discussed later, *Tubomphalus* Perner, 1903 (2a, pl. 42; 2b, p. 255), *Turbinilopsis* de Koninck, 1881 (4, p. 89) and *Isonema* Meek and Worthen, 1866 (5a, p. 251), rest on genotypes that seem to be sufficiently removed from the main phyletic line of descent to be regarded as distinct genera, or at least of subgeneric rank; but the remaining four names are based on genotypes that I cannot but regard as strictly congeneric and hence they are here treated as synonyms. The genotype species on which these last four generic names are based are:

Anomphalus Meek and Worthen, 1866 (5b, p. 268). Genotype by original designation, *Anomphalus rotulus* Meek and Worthen, Pennsylvanian.

Rotellina de Koninck, 1881 (4, p. 91). Genotype by monotypy, *Rotellina planorbiformis* de Koninck, Mississippian.

Pycnomphalus Lindström, 1884 (6, p. 153). Genotype by subsequent designation (2b, p. 253) *Pycnomphalus obesus* Lindström, Silurian.

Antirotella Cossmann, 1912 (1, vol. 11, p. 79), Genotype by original designation, *Rotella heliciformis* Goldfuss, Devonian.

The name *Anomphalus*[4] was proposed by Meek and Worthen in 1866 (5b, p. 268) with *Anomphalus rotulus* Meek and Worthen as genotype by original designation. Meek seems to have been quite sure that the specimens of the genotype species, *A. rotulus* described at the same time, were strictly anomphalous for he says explicitly that they are not only imperforate but "wanting the callus seen filling the umbilical depression" in *Rotella* (= *Umbonium*). I have not had the privilege of examining the holotype but I have available a plaster cast of it and some excellent specimens from the same bed not far from the type locality which may be regarded as topotypes.[5] The topotype specimens did indeed seem to be anomphalus, until the umbilical region was very carefully cleaned with a needle under a microscope. When this was done, however, they were seen to be cryptomphalous rather than anomphalous (see pl. 11, fig. 2*c*) and a thin-section of a specimen shows that they were even hemiomphalous, with a rather widely open umbilicus at earlier ontogenetic stages (see pl. 12, fig. 2). Thus, accepting

[4] There is a grave question in my mind as to the availability of the name *Anomphalus* Meek and Worthen. A name of obviously the same derivation and differing only in gender, *Anomphala*, was proposed by Hermannsen in 1846 for another genus of gastropods. The International Commission on Zoological Nomenclature in the Code, and in one of its rulings (Opinion 86) seems to have officially validated names which differ only in gender. I say "seems" advisedly for the matter is not at all clear. And again in another ruling (Opinion 115) it seems to have established the principle that a name so differing from a previously proposed name for a *closely related* genus may be regarded as an homonym. Both *Anomphalus* and *Anomphala* are gastropods and the question as to whether or not they are closely enough related to be governed by Opinion 115 may well be raised. It would seem that the Commission should clarify the point for it is likely to arise frequently and to remain a source of instability until definitely settled. I am entirely in accord with the ideas so well expressed by Mr. B. B. Woodward in the discussion of Opinion 115 that names differing only in gender are the same and that the last proposed ought to be suppressed as an homonym. I shall not, however, abandon *Anomphalus* with the matter in its present unsettled state.

[5] For both of these I am indebted to Dr. J. Marvin Weller who has so generously obtained for me type material of many of Meek's species that I have had to deal with.

the authenticity of my material, I am forced to conclude that Meek was deceived by matrix when he described the species and the genus as anomphalous.

The ontogenetic change in *A. rotulus* from an almost phaneromphalous condition at neanic stages through a hemiomphalous to a cryptomphalous condition at ephebic stages is an interesting commentary on the value of any of these conditions as generic criteria in the group under discussion.

I do not have any specimens of *R. planorbiformis* the genotype of *Rotellina*[6] but de Koninck's figures of the holotype (reproduced as pl. 11, figs. 4*a*, *b*, *c*) show very clearly a simple, depressed rotelliform gastropod with an open umbilicus and a circum-umbilicul funicle. I can see no reason to hold *Rotellina* as generically distinct from *Anomphalus*.

Pycnomphalus obesus Lindström, the genotype of *Pycnomphalus*, as may be seen from Lindström's beautiful illustrations reproduced herein (pl. 11, figs. 3*a*, *b*, *c*, and pl. 12, fig. 3) differs from *Anomphalus rotulus* only in that the circum-umbilical funicle fails to close completely the umbilicus at any ontogenetic stage. From *Rotellina planorbiformis* it differs only in its somewhat less flattened spire.

Although I have topotype specimens of *Rotella heliciformis* Goldfus, the genotype of *Antirotella* Cossmann, none of them are as well preserved as that figured by Cossmann (1, vol. 11, pl. 7, figs. 42–43) and I am therefore reproducing Cossmann's figures on Plate 11, figs. 5*a*, *b*. *A. heliciformis* agrees in every essential particular with the types of genera we are discussing and *Antirotella* may also be placed in the synonymy of *Anomphalus*. To sum up, it seems proper to regard *Rotellina* de Koninck 1881, *Pycnomphalus* Lindström 1884, and *Antirotella* Cossmann 1912 as synonyms of *Anomphalus* Meek and Worthen 1866.

Anomphalus Meek and Worthen may be defined as follows: Rotelliform to sub-lenticular gastropods with low or flattened spire, a rounded periphery deeply embracing whorls, shallow sutures and a somewhat flattened, hemiomphalous or cryptomphalous base. A callus is always present though the development of the callus and therefore of the funicle is variable within the genus, and in some species within the life history of the individual, so that the funicle may be small and circum-umbilical or greatly developed and completely filling the umbilicus. The aperture is subcircular to sub-oval, and the outer lip oblique in side view. The details of the inner lip are dependent upon and vary with the development of the callus. Ornamentation is gen-

[6] Prof. Louis Agassiz cites in his *Nomenclator Zoologious*, 1842–1846, the genus *Rotellina*, infusorian, as of Serres 1836. An examination of the source cited (L'Academie des Scienc, *Comptes Rendus*, vol. 3, 1836, p. 61) shows however that the name *Rotelline* (not *Rotellina* as cited by Agassiz) occurs in an anonymous report of a communication from M. Serres. The name therefore is invalid for several obvious reasons and seems not to conflict with *Rotellina* de Koninck unless used differently in some later publication, a possibility I have been unable to check. The supposed infusorian is also probably a Bacterium and hence may belong to the field of Botany rather than Zoology.

erally wanting. The shell is composed of two layers, the inner layer presumably nacreous in life. The nucleus is low, simple and dextral.

Isonema depressum Meek and Worthen 1866, genotype of *Isonema* Meek and Worthen 1866 (5a, p. 251) is in many important respects so very much like *Anomphalus rotulus* that there has been grave question in my mind as to whether they should be held to be generically distinct.

Meek's specimens of *Isonema depressum*, the genotype of *Isonema*, were derived from the well known cherty horizon of the Columbus limestone (Onondaga, Devonian) at White Sulphur Springs, Delaware County, Ohio. I have before me, through the courtesy of Prof. T. E. Savage of the University of Illinois, Meek's holotype. I also have, through the courtesy of Dr. G. Marshall Kay of Columbia University, a suite of three specimens from the same horizon at Dublin, Ohio, and another from Columbus, Ohio, both only a few miles from the type locality. The specimen from Columbus is a syntype of *Isonema humile* Meek which is almost certainly a synonym of *I. depressum* Meek and Worthen. The holotype of *I. depressum* is a young individual and the syntypes of *I. humile* are large and mature. The three specimens from Dublin bridge the gap and show that the supposed differences are ontogenetic.

Photographs of Meek's holotype of *I. depressum* and of one of the Dublin specimens are shown on Plate 11, figs. 1*a–e*. From these it may be seen that it is a rotelliform gastropod with a somewhat flattened, cryptomphalous base, a rounded periphery only approaching angularity and fasciculated lines of growth at early stages. Meek seems to have erred in a number of particulars in considering this species and the genus based on it. First his holotype is not, as he thought, mature but is a young example. Secondly, the base of his specimen was eroded enough to obliterate the fasciculation of the growth lines below the periphery, a condition he thought to be natural. Thirdly, the characters of the inner lip and of the umbilical callus are also somewhat modified by erosion. Although the Dublin specimen (pl. 11, figs. 1*d*, *e*) has lost much of the inner lip, the nature of the umbilical region can be seen better on it than on the holotype. The inner lip is somewhat excavated, as described by Meek, but the amount of excavation has been exaggerated on the holotype by erosion.

Isonema depressum resembles *Anomphalus rotulus* in its general form, in the sweeping obliquity of its outer lip, and in its umbilicus and funicle, though its base is seemingly cryptomphalous at all stages. *I. depressum* differs in its larger size, its subangular periphery and in the fact that at early stages its growth lines are fasciculated into transverse lirae. The two species also differ somewhat in the characters of the inner lip, but these seem to be dependent upon the details of development of the callus and therefore to be of minor consequence in the group under consideration.

It seems best in view of the ornamentation on *I. depressum* at young stages and in view of its sub-angular periphery, to hold *Isonema* distinct from *Anomphalus*, but it should be noted that its affinities seem to be with that genus rather than with *Callonema* (=*Strophostylus*) as has sometimes been supposed.

Tubomphalus, Perner 1903 seems to agree in every way with *Anomphalus* as here conceived except that the final whorl in the adult of the genotype, *T. crenistra* (Barrande) is free for a short distance. This character would seem to set it apart from the species of *Anomphalus* but perhaps no farther than as a subgenus. *Turbinilopsis* de Koninck includes besides the genotype, *T. inconspicuus* de Koninck, a number of species with many characters quite similar to those of *Anomphalus* but with the funicle low and flat and entirely within the umbilicus, a character that seems sufficiently different from the essentially circum-umbilical position in *Anomphalus* to permit it to stand as an independent but probably related genus. There is, on the other hand, that about *Turbinilopsis* that suggests the Naticidae.

The range of *Anomphalus* as here conceived is Ordovician to Pennsylvanian. It will probably be found in the Permian as well but I know no example at present.

GENUS ANGYOMPHALUS COSSMANN, 1915

The name *Angyomphalus* was proposed by Cossmann in 1915 for the reception of *Raphistoma radians* de Koninck and *R. junius* de Koninck the former of which he designated genotype (1, vol. 10, p. 152). These two species from the Mississippian rocks of Belgium and the two American Pennsylvanian species here referred to the genus remind one rather strongly of *Anomphalus* Meek and Worthen, as here emended, except that a row of nodes or short radiating costae appear on the upper surface of the whorls just below the suture. Cossmann placed *Angyomphalus* as a subgenus of *Rotellomphalus* Perner which he in turn places in the Euomphalidae de Koninck, in neither of which actions am I prepared to follow him. The affinities of *Angyomphalus* seem to be clearly with *Anomphalus* and *Isenema* in the Trochoturbinidae.

Angyomphalus may be defined as follows:

Rotelliform to sub-lenticular gastropods, with an arched spire, rounded to sub-angular periphery, moderately embracing whorls, moderately well defined sutures and gently rounded to somewhat flattened phaneromphalus, cryptomphalus, or perhaps anomphalus base. The outer lip is thin and the inner lip very oblique and somewhat thickened. The parietal inductura is moderately thickened and may form a moderate callus within, or covering, the umbilicus. The sole ornamentation is a row of nodes, or short radially arranged costae, on the upper surface of the whorls just below the suture. The nucleus, though not sufficiently known for certainty, seems to be low, simple and dextral.

Cossmann is inclined to stress the sub-angular periphery of the genotype as of generic importance but this feature fails to impress one on examination of de Koninck's figures (reproduced as Figs. 6 *a–b* on Plate 8 herewith) or of the rather poor photograph supplied by Cossmann himself (1, vol. 10, pl. 6, figs. 22–25). In any case the periphery of the two American species here referred to the genus is well rounded. These two American forms are *Angyomphalus moniliferus* (White), originally described as *Naticopsis*, and *A. minutus* (Sayre), descriped as *Naticopsis* (?). The latter is here redescribed from the St. Louis Pennsylvanian outlier. Neither are more than remotely related to *Naticopsis*.

One feature of *A. moniliferus* as described by White (22, p. 168, pl. 42, figs. 3 *a–c*), a distinct sinus in the outer lip just below the circlet of nodes, has not been noted for any of the three other forms referred to the genus. As far as I am aware, the outer lip of the genotype is unknown. In one of my specimens of *A. minutus*, my cyrioplesiotype (pl. 8, figs. 5 *b*, *c*), the outer lip is only very slightly broken, though the lip itself has grown from a previous break and may be modified somewhat thereby. At any rate no sinus of any kind is shown. Indeed the sinus so circum-

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EXPLANATION OF PLATE 8

FIGS. 1 *a–h*—*Strophostylus* (*Anematina*) *minutissimus* Knight, n. sp. Page 47. All figures ×20. *a*, Dorsal aspect of a paratype to show form. *b*, the same as *a* but photographed to show color marking. *c*, another paratype, apertural view. *d*, The holotype apertural view. *e*, A paratype to show color marking. *f*, The same specimen as *e*, to show form. *g*, Apertural view of another paratype. *h*, Same specimen as *g* from dorsal view to show color.

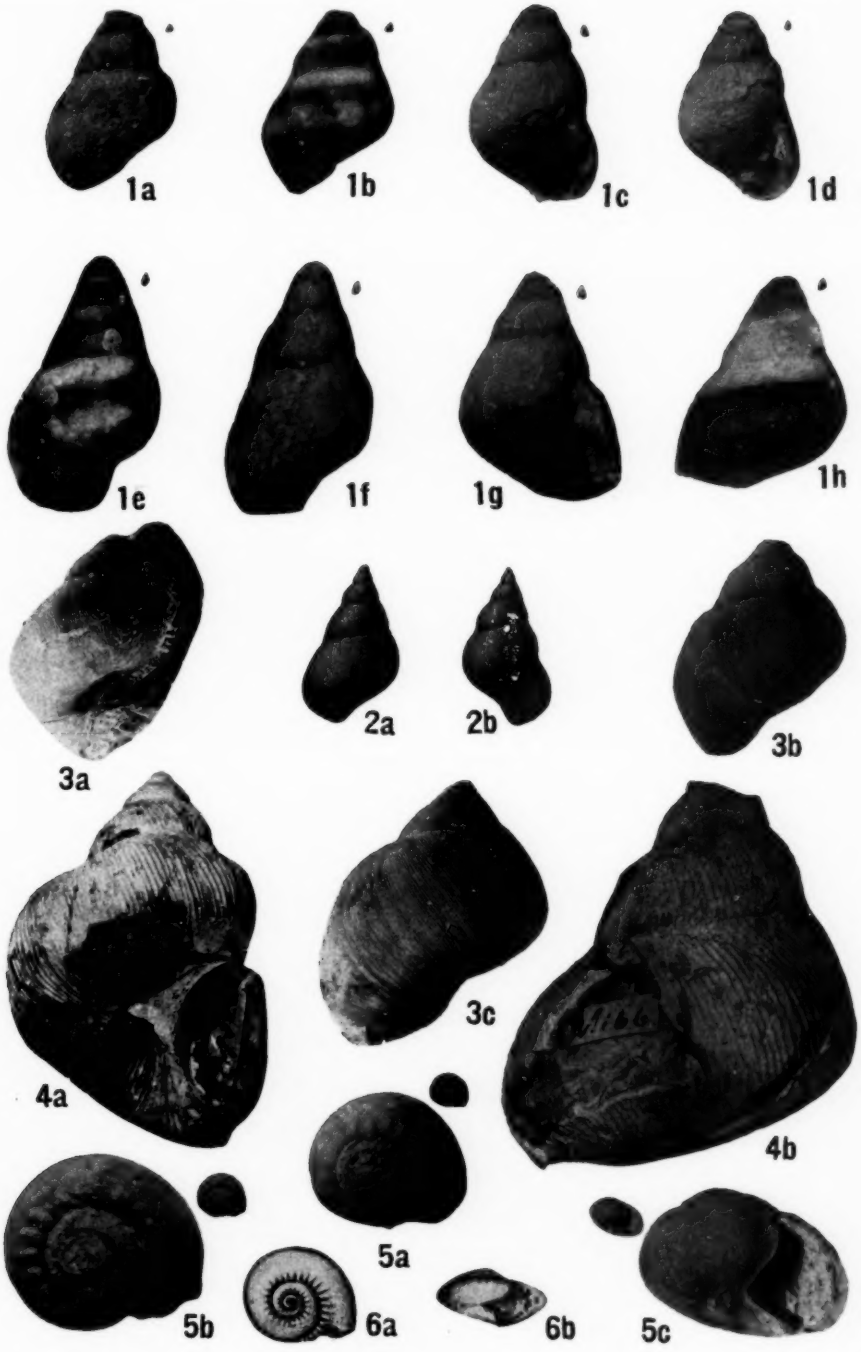
2—*Strophostylus* (*Anematina*) *proutanus* (Hall). *a* and *b*, The holotype, (×2), after Whitfield, figs. *33* and *34*, plate *8*, Bull. Am. Mus. Nat. Hist., vol. 1.

3 *a–c*—*Strophostylus* (S. S.) *elegans* (Hall), the genotype of *Strophostylus* Hall. Two of Hall's syntypes, (×2). *a*, The specimen here designated the lectoholotype of the species, photographed to show phaneromphalous base. *b*, The lectoholotype, dorsal view to show form and ornamentation. *c*, A paratype, somewhat larger and more robust than the holotype. The holotype is the specimen figured as 1*c* (1*a* in error on plate) and the paratype as 1*d* by Hall on plate *55*, Paleontology of New York, vol. 3.

4 *a–b*—*Strophostylus* (S. S.) *bellatulus* (Hall). Two of Hall's heautotypes of the genotype of *Callonema* Hall (not Conrad), (×2). *a*, The specimen figured as *13*, plate *14*, Paleontology of New York, vol. 5, pt. 2. This specimen is photographed to show the umbilicus. *b*, The specimen figured by Hall as *14*, on the same plate as the preceding, photographed from dorsal view to show form and ornametation. This species is to be compared with *S. elegans*. The specimens of *S. bellatulus* and *S. elegans* were made available to me through the kindness of Dr. Chester A. Reeds of the American Museum of Natural History who also was good enough to permit me to remove the matrix from the base of one of the specimens of the latter thus uncovering for the first time the important apertural characters.

5 *a–c*—*Angyomphalus minutus* (Sayre). Page 55. All figures ×4. *a*, Sayre's holotype. *b* and *c*, My cyrioplesiotype, apical and apertural views, respectively.

6 *a–b*—*Angyomphalus radians* (de Koninck), the genotype of *Angyomphalus* Cossmann. Reproduction of de Koninck's figures of the holotype. Cossmann's photographs of a topotype specimen (1, vol. 10, pl. 6, figs. 22–25) show that the columellar lip of the species is quite oblique as in *A. minutus* Sayre.



Knight, Pennsylvanian gastropods

stantially described and figured in the growth lines of the holotype of White's species may be itself due to a repaired break, just such a break as is shown on the holotype of Sayre's species (pl. 8, fig. 5 *a*). I have not studied White's specimens and hence cannot reach a definite conclusion. I am inclined to think, however, that the two described Pennsylvanian species are congeneric with *A. radians* and that there is no sinus in the lip of any of them.

It will be noted that the two Pennsylvanian species are either cryptomphalous or anomphalous while the holotype is phaneromphalous with a thin, circumumbilical callus. This difference I do not consider of generic rank in the group of species including *Anomphalus* and its closer relatives.

ACKNOWLEDGMENTS, LOCALITIES AND LOCATION OF TYPE SPECIMENS

My indebtedness to the many who have so generously given of their time or have loaned specimens has been acknowledged in previous papers of this series (3) or appear at appropriate places in the text.

A stratigraphic section and registers of localities have been furnished with some of the previous papers (3a, 3c) and these cover all of the collecting localities mentioned in this paper except Locality 40. Locality 40 is on the south side of Lackland Avenue, one block south of Arsenal Street and two blocks east of Kingshighway Boulevard in St. Louis where there is a shale pit. The shale mined is that of the lower part of the Pleasanton formation and the pit bottoms on Pawnee limestone from which latter the fossils are derived.

The illustrated specimens (except those that are announced as borrowed) are deposited in the collections of the Peabody Museum of Natural History at Yale University. Unfigured types will be deposited with the United States National Museum at Washington, at Washington University in St. Louis and at the Musée Royale d'Histoire Naturelle at Bruxelles, Belgium.

DESCRIPTION OF SPECIES

Family TROCHO-TURBINIDAE Koken, 1896

Genus STROPHOSTYLUS Hall, 1859 emend Knight

STROPHOSTYLUS (ANEMATINA) MINUTISSIMUS Knight, n. sp.

Plate 8, figures 1*a–h*; plate 12, figure 7

Minute turbinate gastropods with moderately high spire, very gently convex sides and rounded, minutely

	A	B	C	D
Number of whorls	4	4	3½	4
Height	1.25 mm.	1.35 mm.	1.20 mm.	1.55 mm.
Width	.78 mm.	.85 mm.	.85 mm.	1.00 mm.
Ratio of height to width	1.60	1.60	1.42	1.55
Ratio of height of body whorl to total	.76	.73	.79	.71
Pleural angle	48°	50°	51°	51°

A. The holotype, seemingly a mature specimen (pl. 8, fig. 1*d*).
B. A paratype (pl. 8, fig. 1*c*).
C. A paratype (pl. 8, figs. 1*a*, *b*).
D. A paratype (pl. 8, figs. 1*g*, *h*).

phaneromphalous base; whorl profile gently arched; sutures slightly impressed; outer lip thin; columellar lip thin and slightly reflexed; aperture sub-oval; without sculpture; shell with two layers to be seen most distinctly near base, the outer layer strongly pigmented; color pattern, two revolving dark bands on lighter background, dark bands seemingly not well defined until fourth whorl; nucleus simple and dextral.

This minute species is moderately abundant in my material and the specimens seem to be adult in spite of their small size. Its color banding and even its general outline suggests the young of *Auriptygma virgatum* Knight, but its very different apertural and umbilical characters and its shell structure relieve it of suspicion. It is perhaps closest in size and form to *S.* (*A.*) *micula* (Girty) described as *Macrocheilus?* but that species seems to have a rounder whorl profile and deeper sutures. The similarity of the color markings to those of *S.* (*A.*) *proutana* (Hall), the subgenotype, is worthy of note (14, pl. 3, figs. 8–13).

I have 18 specimens of this tiny species, all from Zone R near the top of the Labette shale at Locality 43. Most of them show color markings.

Holotype Yale Peabody Museum No. 13,855.

Genus MICRODOMA Meek and Worthen, 1866

MICRODOMA CONICUM[7] Meek and Worthen

Plate 9, figures 1*a–i*; plate 12, figures 6*a*, *b*

Microdoma conica MEEK AND WORTHEN, *1866*, Acad. Nat. Sci. Phila., Proc. p. 269; *1873*, Ill. Geol. Survey, vol. 5, p. 598, pl. 28, fig. 2*a–b*, lower Pennsylvanian, Macoupin Co., Illinois.

[7] Cossmann emended Meek's generic name to *Microdomus*, I feel without warrant. While Meek does not give the derivation of *Microdoma*, it is evidently from the Greek μικρός, small, and from δῶμα, -ατος a neuter noun signifying a house (and therefore a shell). This would require that the specific name receive a neuter termination and that is the plan I have followed. Meek (and many others) frequently made the minor error of regarding names derived from the Greek, ending in a, as necessarily feminine. Cossmann

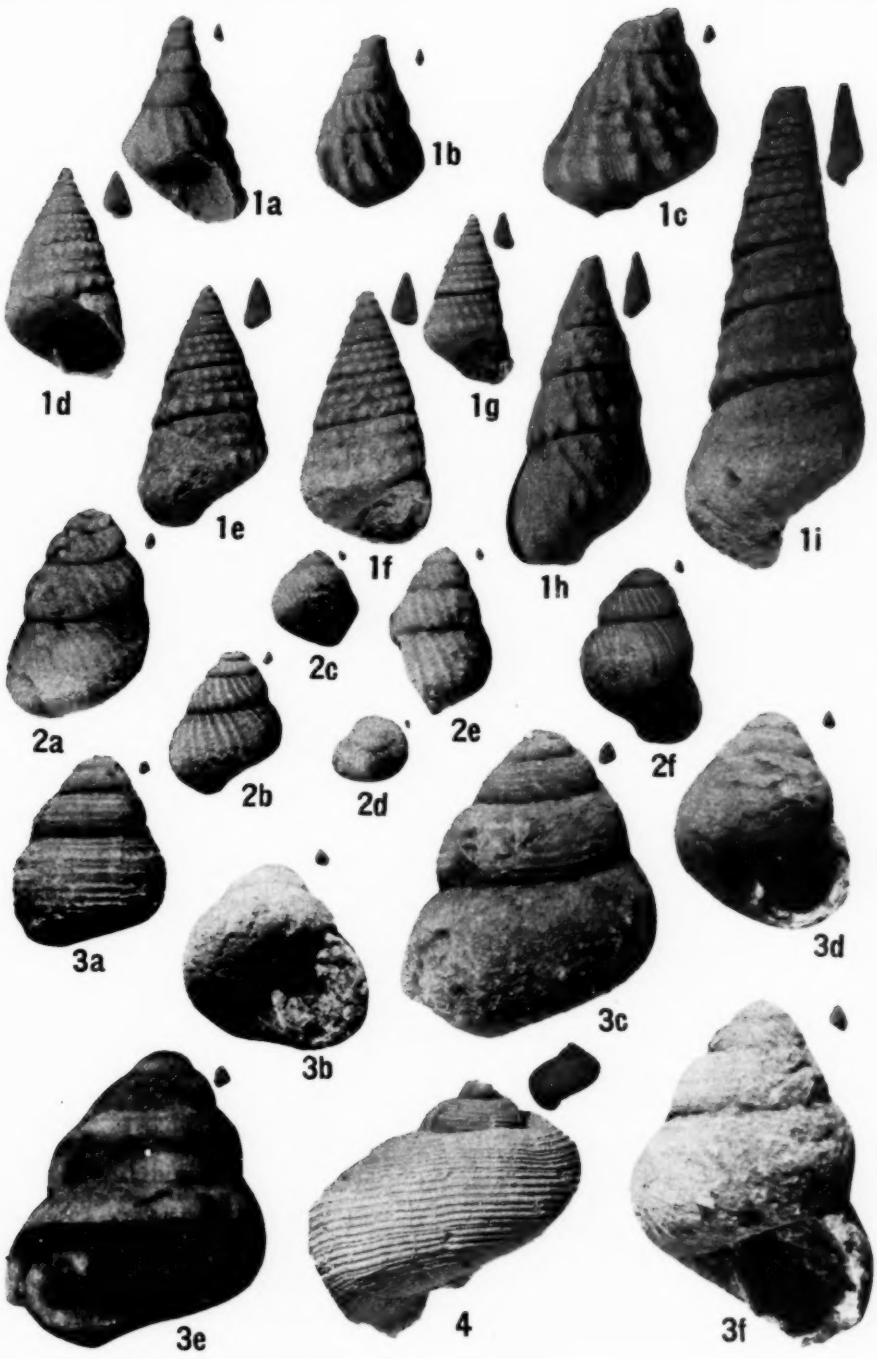
EXPLANATION OF PLATE 9

FIGS. 1 *a–i*—*Microdoma conicum* Meek and Worthen. Page 48. *a*, *b* and *c*, Juvenile plesiotype specimens, (×15), to show nuclei and development of the ornamentation from simple *Strophostylus*-like transverse lirae on the nucleus, through almost unbroken transverse costae on the first neanic whorl or two, to revolving rows of nodes formed by the super-position of two revolving grooves on the transverse costae. *d*, *e*, *f*, *g* and *h*. Mature plesiotype individuals, (×5). *i*, The cyrioplesiotype, an unusually slender individual, (×5), showing gerontic suppression of ornamentation on the final whorl. Specimens *a* to *h* are from the top of the Labette shale at Locality 43, while specimen *i* is from the base of the Pawnee limestone at Locality 6.

2 *a–f*—*Eucochlis perminuta* Knight, n. sp. Page 53. All figures ×15. *a*, A paratype showing gerontically obscured ornamentation on last quarter of final whorl. *b*, A paratype, a mature individual, dorsal view. *c* and *d*, Paratypes, young individuals showing more robust form at neanic stages. Compare with first three whorls of preceding. *e*, A paratype. *f*, The holotype, apertural view.

3 *a–f*—*Araeonema virgatum* Knight, n. sp. Page 52. All figures ×15. *a*, A paratype showing ornamentation. *b*, A paratype showing basal characters. *c*, The holotype, dorsal view. *d*, Basal view of another paratype. The anterior lip is broken and the apparent projection on the inner lip is not natural but is due to the break. *e*, The holotype, photographed to show color marking. *f*, A large paratype, apertural view.

4—*Araeonema sp.* Page 52. The only specimen, ×4.



Knight, Pennsylvanian gastropods

	A	B	C	D
Number of whorls	12[a]	9[b]	8[c]	7
Height	14.6 mm.	9.0 mm.	7.0 mm.	4.5 mm.
Width	5.0 mm.	3.93 mm.	3.5 mm.	2.5 mm.
Ratio of height to width	2.80	2.37	2.05	2.00
Ratio of height of body whorl to total	.43	.50	.53	.56
Pleural angle	22½°	26½°	29°	33°

A. The cyrioplesiotype, my largest and slenderest specimen (pl. 9, fig. 1*i*).
B. A plesiotype (pl. 9, fig. 1*h*).
C. A plesiotype (pl. 9, fig. 1*e*).
D. A plesiotype (pl. 9, fig. 1*g*).

[a] Estimated on the assumption that 4 apical whorls are missing.
[b] Estimated on the assumption that 3 apical whorls are missing.
[c] Estimated on the assumption that 1 apical whorl is missing.

Slender sub-conical gastropods with rather high spire, nearly straight sides and a flatly rounded, minutely phaneromphalous base; whorl profile flat; sutures rather shallow but sharply defined; aperture sub-oval with thin lips; outer lip oblique in side view; inductura thin; shell distinctly two-layered; the ornamentation on the nucleus (the first three or four whorls) consists of fine fasciculated lines of growth or lirae, on the fourth or fifth whorl transverse costae paralleling the growth lines appear but are soon broken into three revolving rows of nodes by the superposition of two revolving grooves that become relatively wide as growth proceeds; the color seems to have been uniformly dark, almost black; nucleus of 3 or 4 whorls, rather high spired, simple, dextral and ornamented as noted above.

M. conicum is so distinctive in appearance that it hardly needs comparison with any American species known to me. The identification of my specimens is confirmed by a topotype specimen loaned me by Dr. J. M. Weller.

I have 313 specimens of this species, 242 of them juveniles of five or six whorls; 23 specimens were derived from the base of the Pawnee limestone at locality 6, six specimens from the same horizon at locality 40 while 284 specimens are from the top of the Labette shale at locality 43. Of the last, two are from Zone G and the others from Zone R.

Cyrioplesiotype, Yale Peabody Museum No. 13,856.

apparently assumed that Meek had derived the last half of the name from the Greek δόμος, masculine, an alternative of δῶμα with the same meaning. It, of course, might have been derived from δόμα, neuter, a gift. In any case it seems wiser to leave the generic name as Meek wrote it, but it does seem necessary to regard it as neuter rather than feminine.

Genus YUNNANIA Mansuy, 1912

YUNNANIA SUBSINUATA (Meek and Worthen)

Plate 10, figures 2*a–f*; plate 12, figure 9

Pleurotomaria subsinuata MEEK AND WORTHEN, *1860*, Phila. Acad. Nat. Sci., Proc. p. 460; *1866* Ill. Geol. Survey, vol. 2, p. 358, pl. 28, fig. 4*a–d*, lower Pennsylvanian, Hodges Creek, Macoupin Co., Illinois; ?Sayre *1930* Kansas Geol. Survey, Bull. 17, "Drum" ls. (=Westerville ls.—R. C. Moore), Pennsylvanian, Kansas City, Missouri.

Sub-turbinate gastropods with moderately high spire, gently convex

	A	B	C
Number of whorls	4½	5	6[a]
Height	4.8 mm.	6.0 mm.	10. mm.[a]
Width	4.2 mm.	4.5 mm.	6. mm.
Ratio of height to width	1.14	1.32	1.66[a]
Ratio of height of body whorl to total	.77	.70	.62[a]
Pleural angle	65°	57°	40°

A. The cyrioplesiotype, a youthful individual (pl. 10, fig. 2*a*).
B. A plesiotype, a nearly grown individual (pl. 10, figs. 2*b*, *c*).
C. A plesiotype, a gerontic individual (pl. 10, figs. 2*d*, *e*).

[a] Estimated on the assumption that the first four and one half whorls are missing.

sides and rounded, minutely phaneromphalous base; whorl profile moderately arched; sutures moderately deep; outer lip thin, slightly oblique in side view and with a very slight sinus at the position of the third revolving costa below the suture; anterior and columellar lips thin; aperture sub-circular; ornamentation composed of rather elevated revolving costae, the two close to the suture not so strong as those on the sides and crossed by weak, short, transverse costules which give them a crenulated appearance, the three revolving costae on the sides and the uppermost of those on the base more prominent than the others, those on the base weaker than those on the sides, interspaces rounded grooves, in some specimens with a very fine revolving supplementary thread or lira in the middle of the grooves; shell distinctly two-layered; no color pat-

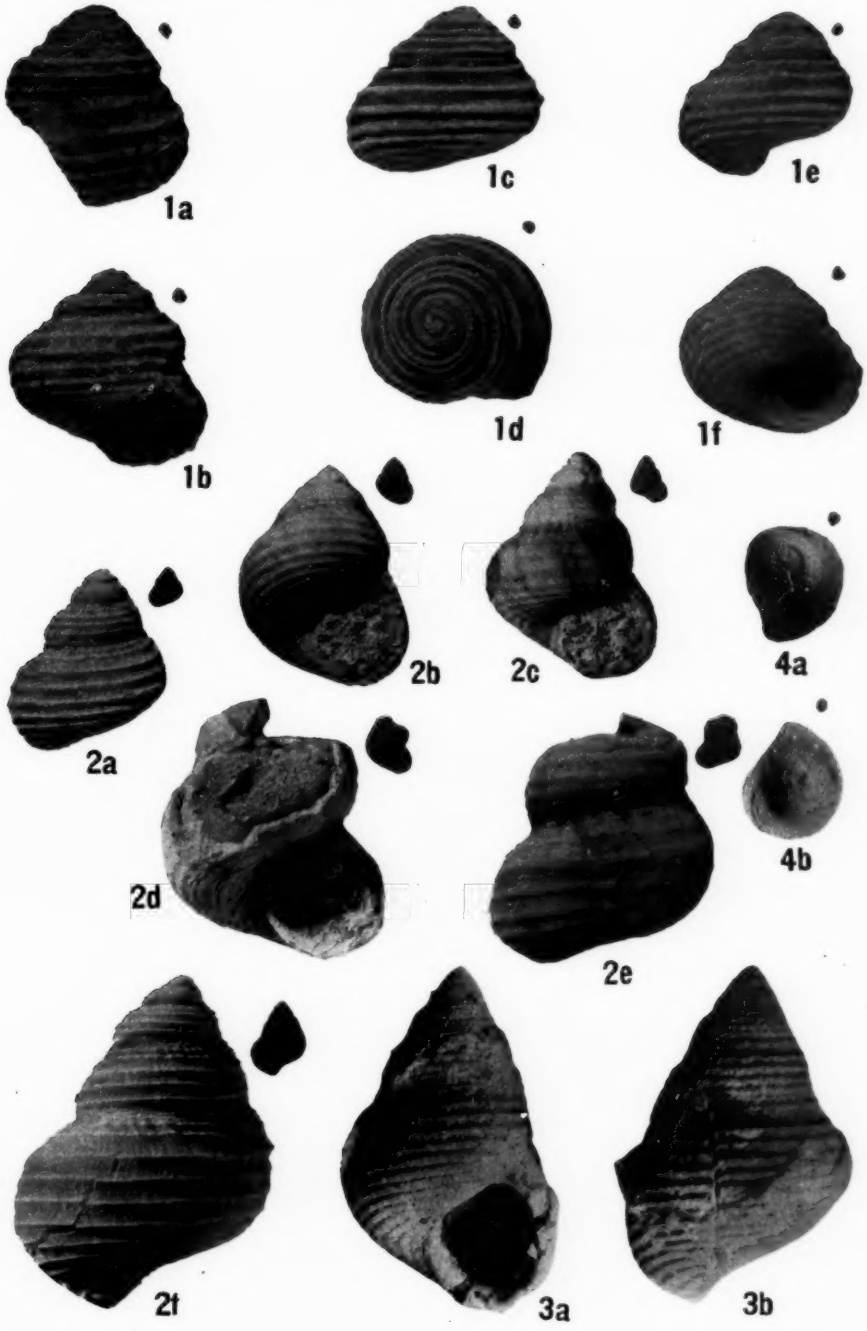
EXPLANATION OF PLATE 10

FIGS. 1 *a–f*—*Rhabdotocochlis rugata* Knight, n. sp. Page 51. All figures ×15. *a* and *b*, The holotype, a very perfectly preserved specimen, side and apertural views respectively. Note the obliquity of the outer lip and the shelf-like excavations of the margins within the aperture. *c* and *d*, Dorsal and apical views of a paratype to show details of ornamentation. *e* and *f*, A paratype. Note the minute umbilicus.

2 *a–f*—*Yunnania subsinuata* (Meek and Worthen). Page 49. All figures ×5, *a*. The cyrioplesiotype, a half-grown individual with the nucleus and outer shell-layer intact. *b*, A plesiotype, a nearly full grown individual retaining only the inner, presumably nacreous shell layer. The specimen is tilted back to show basal characters. *c*, The same specimen as the preceding showing the zig-zag course of the growth lines in the inner shell-layer. *d*, Apertural view of a broken gerontic individual, a plesiotype. *e*, Dorsal view of the same specimen as the preceding with some of the outer shell-layer preserved. Note the slight sinus shown by the growth lines above the principal revolving ridge and the thin revolving lira in the groove below the same ridge. The thin revolving lirae may occur in several of the grooves. *f*, A specimen from Meek's and Worthen's type horizon near the type locality. Note the slight sinus over the principal revolving ridge shown by the beautifully preserved growth lines. Specimen loaned by Dr. J. Marvin Weller.

3—*Yunnania termieri* Mansuy, (×4), after Mansuy (19, plate *18*, figs. *20 a–b*). The holotype of the genotype of *Yunnania* Mansuy. The preservation of surface details is too poor to show whether or not the slight sinus developed in *Y. subsinuata* is also to be found in the genotype species. The unconventional lighting is due to my reversal of the original orientation of Mansuy's figures.

4 *a–b*—"Turbinid" operculum (×10). Page 56. *a*, Inner surface. *b*, Outer surface. I am inclined to attribute this operculum to *Yunnania subsinuata*, but proof is wholly lacking.



Knight, Pennsylvanian gastropods

tern preserved; nucleus simple, dextral and not sharply demarked.

Meek placed this species in the genus *Pleurotomaria* because of a "shallow sinus" in the growth lines crossing the upper of the stronger costae passing around the face of the whorl, and because of a supposed slit-band that is, in fact, non-existent. Few of my own specimens show the sinus, for the outer shell-layer is exfoliated away in most of them, and the inner, probably, nacreous layer seems to show instead a slight sinus at each revolving ridge, a feature that is possibly a mechanical result of the deposition of the nacreous layer over the grooved inner surface of the primary, outer shell. However, one or two specimens do show it and it can be seen readily on some specimens with a different preservation collected in Green County, Illinois, from the same horizon as that from which Meek's specimens came and most generously loaned my by Dr. J. M. Weller. Dr. Weller has compared these virtual topotype specimens with the holotype in the University of Illinois and confirms that they are identical in every respect with the holotype. Neither my specimens nor the specimens loaned my by Dr. Weller have a slit or slit-band and Dr. Weller informs me that the holotype does not either.

I am placing Sayre's identification from the Westerville limestone at Kansas City, Missouri (or Turner, Kansas?) in the synonymy with some hesitation. Sayre merely quotes Meek's description and his rather poor figure seems to show only two larger revolving costae on the face of the whorl instead of three or four. Still, while I am not convinced that he had the same species, I feel reasonably sure that he had. It will be necessary to examine his specimens to be certain.

I have eight specimens of the species from the base of the Pawnee limestone at Locality 6 and one specimen from the top of the Labette shale at Locality 43.

Cyrioplesiotype, Yale Peabody Museum No. 13,857.

Genus RHABDOTOCOCHLIS Knight, n. gen.

RHABDOTOCOCHLIS RUGATA Knight, n. sp.

Plate 10, figures 1*a–f;* plate 12, figure 4

Minute sub-turbinate almost globular gastropods with a relatively low spire, convex sides and rounded, minutely phaneromphalus base; whorl profile moderately arched, sutures moderately deep; aperture sub-circular and shell much thickened just within the margins, the thickening being greatest at the anterior columellar angle and forming a shelf-like area within the margin and particu-

	A	B	C
Number of whorls	4	4	3½
Height	1.80 mm.	1.86 mm.	1.43 mm.
Width	1.73 mm.	1.70 mm.	1.53 mm.
Ratio of height to width	1.04	1.09	.94
Ratio of height of body whorl to total	.78	.68	.79
Pleural angle	64°	67°	75°

A. The holotype (pl. 10, figs. 1*a*, *b*).
B. A paratype (pl. 10, figs. 1*c*, *d*).
C. A paratype (pl. 10, figs. 1*e*, *f*).

larly on the columellar lip; outer lip straight and oblique; parietal inductura very thin; ornamentation strong, sharp, revolving costae separated by rounded furrows, the furrow between the first two costae below the suture being a little the widest, about ten costae in all, the five of them on the base being smaller than those above; shell seemingly two-layered; no color pattern preserved; nucleus simple and dextral.

This remarkable little shell seems to be quite unique and hardly needs comparisons. Its resemblance to the young of *Yunnania subsinuata* (Meek and Worthen) is only superficial for the coarse sharp costae and thickened shell serve easily to distinguish them.

I have 81 specimens, all from Zone G at the top of the Labette shale at Locality 43.

Holotype Yale Peabody Museum No. 13,858.

Genus ARAEONEMA Knight, n. gen.

ARAEONEMA VIRGATUM Knight, n. sp.

Plate 9, figures *3a–f;* plate 12, figure 8

slightly oblique in side view; anterior and columellar lip thin; aperture sub-quadrate; sculpture composed of rather fine, revolving lirae which are frequently of uneven strength owing to the intercalation of new lirae on the later whorls, about 5 to 7 lirae between sutures on the third whorl and from 6 to 10 on the fourth; base also with fine revolving lirae; shell two-layered; color pattern a single narrow, dark revolving band passing around the whorls at about the middle of the whorl face; nucleus simple, dextral and not sharply marked off.

A. virgatum is rather abundant in my collections and is easily recognized by its form and ornamentation.

I have 61 specimens, all from Zone R near the top of the Labette shale at Locality 43.

Holotype, Yale Peabody Museum No. 13,859.

ARAEONEMA ? sp.

Plate 9, figure 4

I have from near the top of the Labette shale at Locality 43 a single very much mashed and distorted specimen with ornamentation much as described for *A. virgatum* Knight. The many specimens of *A. virgatum* may possibly be the young of this species, or again they may both be

	A	B
Number of whorls	5	5
Height	3.0 mm.	2.7 mm.
Width	2.2 mm.	2.3 mm.
Ratio of height to width	1.36	1.19
Ratio of height of body whorl to total	.71	.73
Pleural angle	41°	46°

A. A paratype, a large specimen (pl. 9, fig. 3*f*).
B. The holotype, a large specimen (pl. 9, figs. 3*c*, *e*).

Small sub-trochoid gastropods with moderately high spire, very gently convex sides and rather flatly rounded, phaneromphalous base; whorl profile gently arched; sutures of moderate depth; outer lip thin, very

entirely distinct and may even be generically unrelated. I must confess that I do not know, but am inclined to believe them at least specifically distinct because, if for no other reason, the rather numerous specimens upon which *A. virgatum* are based seem to be all more or less of a size. Furthermore, the form of the larger specimen under consideration seems quite different though this may be due to the mashing.

I shall not, of course, presume to propose a name on the basis of such poor material.

Yale Peabody Museum No. 13,860.

Genus EUCOCHLIS Knight, n. sp.

EUCOCHLIS PERMINUTA Knight, n. sp.

Plate 9, figures 2*a–f;* plate 12, figure 5

tral and not sharply marked off from the later stages.

This minute species is moderately abundant in my material and the specimens do not seem to be the young of any larger form. That this is the case seems to be substantiated by the crowding and weakening of the transverse costae on larger specimens such as that shown as fig. 2*a* on Plate 9. The spire is much lower in younger stages than in the adult and it might be easy to mistake these relatively more robust smaller specimens for a different species were it not possible to match them with the earlier stages of more mature specimens.

I have 73 specimens of this species, all from Zone R near the top of the Labette shale at Locality 43.

	A	B	C
Number of whorls	3½		4½
Height	1.23 mm.	1.53 mm.	1.77 mm.
Width	.97 mm.	1.06 mm.	1.26 mm.
Ratio of height to width	1.28	1.44	1.47
Ratio of height of body whorl to total	.81	.62	.68
Pleural angle	47°	45°	32°

A. A paratype (pl. 9, fig. 2*b*).
B. The holotype (pl. 9, fig. 2*f*).
C. A paratype, seemingly a gerontic individual (pl. 9, fig. 2*a*).

Minute turbinate gastropods with moderately high spire, gently convex sides and rounded anomphalous base; whorl profile moderately arched; sutures moderately deep; outer lip thin and moderately oblique, anterior and columellar lips thin; aperture subcircular; sculpture consisting of moderately strong, rather sharp transverse costae with rounded interspaces; shell seemingly but not certainly two-layered; color pattern, if any, unknown; nucleus simple, dex-

Holotype Yale Peabody Museum No. 13, 861.

Genus ANOMPHALUS Meek and Worthen, 1866, emend Knight

ANOMPHALUS UMBILICATUS Knight, n. sp.

Plate 11, figures 6*a–j;* plate 12, figure 1

Shell rotelliform with gently arched, almost flat spire; whorl profile gently arched above, rounded more sharply at the sides and rather flat below; base hemiomphalous but with the funicle circum umbilical and reduced

	A	B	C	D
Number of whorls	3½	4¼	4¼	4½
Height	2.4 mm.	3.6 mm.	3.8 mm.	5.0 mm.
Width	4.4 mm.	6.2 mm.	6.4 mm.	8.8 mm.
Ratio of height to width	.59	.58	.59	.57

A. A paratype, a partly grown individual (pl. 11, figs. 6*a–c*).
B. The holotype, a nearly grown individual (pl. 11, figs. 6*d, g, j*).
C. A paratype, a nearly grown individual (pl. 11, figs. 6*e, f, i*).
D. A paratype, my largest specimen (pl. 11, fig. 6*h*).

to a rather sharp angulation at the juncture of the base and the umbilical walls, so that the base appears phaneromphalous; outer lip thin and moderately oblique; anterior lip thin; columellar lip with callus at juncture with anterior lip forming a rounded exterior angle, the callus separated from anterior lip by a small groove and suggesting a mutton chop in section; parietal inductura thin (or possibly wanting); ornamentation none; nucleus simple dextral and not sharply delimited; colors unknown.

A. umbilicatus is indistinguishable from *A. rotulus* Meek and Worthen except by adult umbilical characters, the former being hemiomphalous and almost phaneromphalous through life, while the latter becomes cryptomphalous at ephebic stage of development. Except for this and the correlated differences of the inner lip, the two species seem morphologically identical. *A. umbilicatus* resembles in its umbilical characters *A. planorbiformis* (de Koninck) from the Belgian Mississippian for which de Koninck proposed the generic name *Rotellina* here referred to synonymy, and somewhat less closely *A. obesus* (Lindström) from the Silurian of

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EXPLANATION OF PLATE 11

FIGS. 1 *a–e—Isonema depressum* Meek and Worthen, the genotype of *Isonema* Meek and Worthen. *a, b* and *c*, Three views of the holotype, (×2). The specimen was loaned through the courtesy of Prof. T. E. Savage of the Univ. of Illinois. *d* and *e*, Two views of a topotype, possibly a metatype, (×1), loaned through the courtesy of Prof. G. Marshall Kay of Columbia Univ. These specimens are figured to show how closely the genus *Isonema* resembles *Anomphalus*.

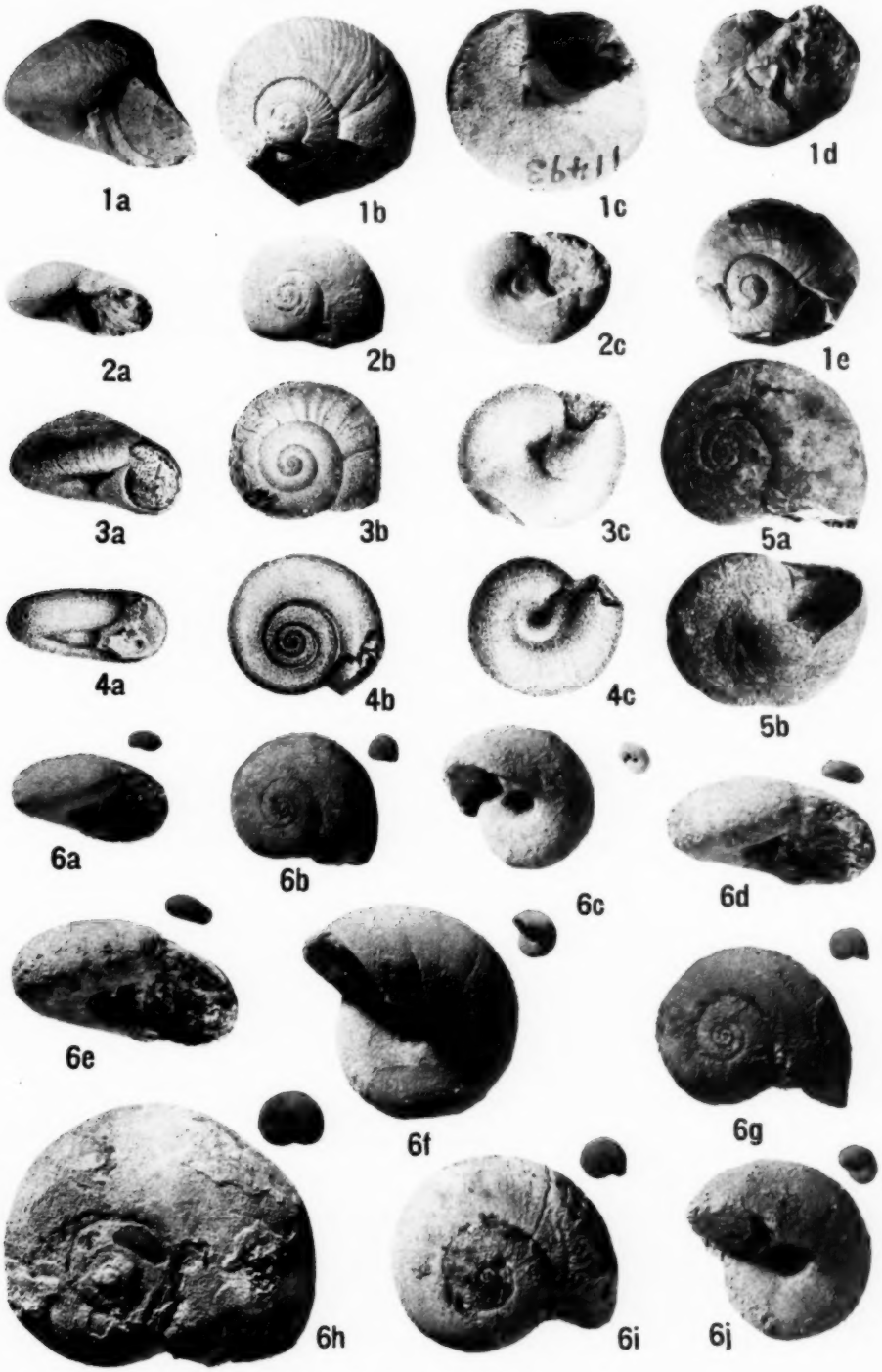
2 *a–c—Anomphalus rotulus* Meek and Worthen. The genotype of *Anomphalus* Meek and Worthen. *a, b,* and *c*, Three views of a specimen, (×5), from Meek's and Worthen's type horizon near the type locality. These figures show for the first time the true characters of this misunderstood species. Specimen loaned by Dr. J. Marvin Weller of the Illinois State Geological Survey.

3 *a–c—Anomphalus obesus* (Lindström), The genotype of *Pycnomphalus* Lindström, (×1). *a, b* and *c*, Copies of Lindström's figures of the holotype.

4 *a–c—Anomphalus planorbiformis* (de Koninck), the genotype of *Rotellina* de Koninck, (×1). *a, b* and *c*, Copies of de Koninck's figures of the holotype. De Koninck says that this species is entirely without an umbilicus, a statement difficult to credit in face of his figures of the holotype.

5 *a–b—Anomphalus heliciformis* (Goldfus), the genotype of *Antirotella* Cossman. *a* and *b*, A topotype specimen, (×1), after Cossman.

6 *a–j—Anomphalus umbilicatus* Knight, n. sp. Page 53. All figures ×5. *a, b, c*, Three views of a nicely preserved paratype, a half grown individual. *d, g, j*, Three views of a paratype. *f* and *i*, Two views of a paratype to show course of the growth lines. *e*, Apertural view of the holotype. *h*, The largest paratype specimen retaining the shell. Note the peculiar form of the inner lip shown in the apertural views and compare with the same character shown in *A rotulus*.



Knight, Pennsylvanian gastropods

Gotland, the type of *Pycnomphalus* Lindström, also regarded as a synonym of *Anomphalus*.

I have fourteen specimens of *A. umbilicatus* from the base of the Pawnee limestone at Locality 6, and one specimen from the Lower Fort Scott limestone at Locality 7. In addition to the foregoing, which are all well preserved and recognizable with certainty, I have two steinkerns from the Upper Fort Scott limestone at Locality 3 and two from the same horizon at Locality 2, one of the latter 10 mm. in width, which are probably referable to this species. From the "Chaetetes" limestone at Locality 43. I have one steinkern that may belong to *A. umbilicatus* but of course may as well be *A. rotulus* Meek and Worthen since the two are indistinguishable when so poorly preserved. The latter supposition is strengthened by the fact that it is from this horizon[8] in Macoupin County, Illinois that Meek derived his specimens.

Holotype, Yale Peabody Museum No. 13,862.

Genus ANGYOMPHALUS Cossmann, 1915

ANGYOMPHALUS MINUTUS (Sayre)
Plate 8, figures 5*a–c*

Naticopsis ? minuta SAYRE, *1930*, Kansas Geol. Survey, Bull. 17, p. 142, pl. 13, figs. 5, 5*a*, Westerville limestone, öolitic member, Pennsylvanian, Muncie, Kansas.

[8] Personal communication from J. M. Weller.

Shell roundly rotelliform with gently arched spire; whorl profile roundly arched, slightly shouldered at position of subsutural nodes, round below; base cryptomphalus or anomphalus, umbilical region covered by a thickened parietal inductura; outer lip thin; columellar lip oblique and thickened; ornamentation, a single row of nodes or very short radiating costae on the upper whorl-surface just below the suture. Nucleus seemingly small, closely coiled, flat and dextral. Color uniformly dark.

I have Sayre's holotype before me, through the courtesy of Prof. Raymond C. Moore of the University of Kansas, and there can be no doubt that my specimens are of the same species. The surface of my specimens is somewhat corroded but Sayre's show a smooth, glossy surface with no growth lines. I have not been able to spare a specimen for sectioning and hence cannot tell whether the base is cryptomphalous of anomphalous. Neither are the nuclei or any of the specimens so well preserved as one could wish.

I have two specimens, both from the top of the Labette shale at Locality 43.

Yale Peabody Museum No. 13,100.

	A
Number of whorls	6
Height	5.02 mm.
Width	6.75 mm.
Ratio of height to width	.75
Ratio of height of body whorl to total	.90
Pleural angle	122°

A. The cyrioplesiotype (pl. 8, fig. 5*b*, *c*).

"Turbinid" operculum, genus and species unknown

Plate 10, figures 4*a–b*

A single well preserved calcareous operculum was found in the material from Zone G, at the top of the Labette shale, at Locality 43. It is paucispiral, uniformly thin, concave on its outer side, and convex on its inner. It is very suggestive of the Turbinidae, as the name is commonly used.

The only suggestion I have as to what species it may belong to is that the only abundant species of the group discussed in this paper and found in the same zone and at the same locality is *Rhabdotocochlis rugata* Knight. But it is difficult to believe that the operculum belongs to that species. It has been my observation in studying the opercula of living forms that they are adapted to withdrawal well within the edges of the aperture, and the bore of the whorls of *R. rugata* is almost a true circle a short way back from the edges. Hence one would expect that that species would have an almost circular operculum. The operculum at hand is decidedly not circular.

EXPLANATION OF PLATE 12

FIGS. 1—*Anomphalus umbilicatus* Knight, n. sp., Page 53. Approximately ×10. Collumellar section of a paratype. Owing to the chalky state of preservation it was impossible to make a section suitable for photography. The illustration is a camera-lucida sketch.

2—*Anomphalus rotulus* Meek and Worthen, approximately ×8. The genotype of *Anomphalus* Meek and Worthen. Photograph of a thin, columellar section. Note that the umbilicus is open, except for extraneous material, above the third whorl. Specimen loaned by Dr. J. M. Weller.

3—*Anomphalus obesus* (Lindström), approximately ×1. The genotype of Pycnomphalus Lindström. A copy of Lindström's illustration of a columellar section. Note the similarity of the circum-umbilical funicle in this species to that of *A. rotulus*, except that it does not completely close the umbilicus at any stage. Also note what seems to be double layering of the shell.

4—*Rhabdotocochlis rugata* Knight, n. sp., Page 51. Approximately ×20. Thin columellar section of a paratype. The columella is lacking in the earlier whorls only through poor orientation of the specimen. The outer shell layer is very thin and does not show well. Note the phaneromphalous columella, the circular bore of the whorls and the thickening of the shell at the anterio-columellar margins of the whorls.

5—*Eucochlis perminuta* Knight, n. sp. Page 53. Approximately ×20. Thin, columellar section of a paratype.

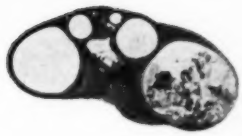
6 *a–b*—*Microdoma conicum* Meek and Worthen. Page 48. *a*, Thin, columellar section of a plesiotype, approximately ×10. Note the minutely phaneromphalous columella and particularly the distinct double layering of the shell. *b*, The lower right hand part of the same specimen at higher magnification (approximately ×40). Note the lighter, outer shell layer, apparently with a prismatic structure and the darker, inner shell layer which was almost certainly nacreous in life, though no true nacreous lustre is preserved.

7—*Strophostylus* (*Anematina*) *minutissimus* Knight. Page 47. Approximately ×20. Thin, columellar section of a paratype. Note minutely phaneromphalous columella.

8—*Araeonema virgatum* Knight, n. sp. Page 52. Approximately ×20. Thin, columellar section of a paratype. Note sub-quadrangular whorl section and phaneromphalous columella.

9—*Yunnania subsinuata* (Meek and Worthen). Page 49. Approximately ×6. Thin, columellar section of a plesiotype specimen from the top of the Labette shale at Locality 43. Note phaneromphalous columella.

1



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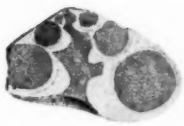

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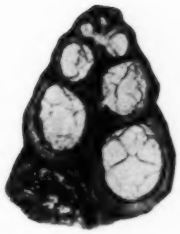

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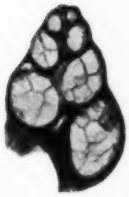
6a

6b



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8

9

Knight, Pennsylvanian gastropods

Further the operculum is far too large for what seems to be the adult size of *R. rugata*.

Morphologically it would fit better with *Yunnania subsinuata* (Meek and Worthen) but though this species occurs at the same horizon and locality, it is not abundant there.

Yale Peabody Museum No. 13, 863.

APPENDIX

CORRECTION TO PREVIOUS PAPER ON *Aclisina* AND *Streptacis*

In a recent paper of this series (3b), dealing with the genera *Aclisina* and *Streptacis*, I made the error of following authority too closely without a sufficiently exhaustive examination of the facts. Thus I overlooked the fact that S. A. Miller had, in 1889, validly designated *Aclisina striatula* (de Koninck) as genotype (9, p. 395) of *Aclisina* de Koninck 1881, a fact that was also overlooked by Mrs. Longstaff (Miss Jane Donald) in her excellent treatise on the genus.[21] Mrs. Longstaff, in her discussions in 1898, showed that *Aclisina*, as conceived by de Koninck, must be broken up into three distinct genera, each based on one of the three species originally referred to it by de Koninck and she then selected *A. pulchra* de Koninck as the type to bear the name *Aclisina* and *A. striatula* as the type of a new section or subgenus of *Murchisonia*, *Aclisoides* Donald.

However, in view of Miller's previous designation of *A. striatula* as the type of de Koninck's genus, *Aclisina* must, unfortunately, be applied to the Murchisonid subgenus to which Mrs. Longstaff gave the name *Aclisoides* and the latter becomes an exact synonym of the former. The genus to which Longstaff and subsequent workers, including myself, have applied de Koninck's name *Aclisina* is thus left nameless. I therefore propose for it the name *Donaldina* Knight. Since *Donaldina pulchra* (de Koninck) is insufficiently known to serve with complete satisfaction as a genotype, and since there is now nothing to compel its selection, I shall designate *Donaldina grantonensis* (Donald) [=*Aclisina grantonensis* Donald] to serve in that capacity. As holotype of *D. grantonensis*, I designate the specimen in the Geological Survey Collection, Museum of Science and Art, Edinburgh, illustrated as figure 7, Plate 4 of Donald's work cited above. The diagnosis given by Longstaff (21, p. 48) for *Aclisina* as previously quoted by me (3b, p. 2) will now apply to *Donaldina* except that the type is, of course, *D. grantonensis* (Donald) instead of *D. pulchra* (de Koninck). The diagnosis that must be applied to *Aclisina* is that given by Longstaff for its exact synonym, *Aclisoides* (21, p. 66), genotype *Murchisonia* (*Aclisina*) *striatula* (de Koninck) [=*Turritella striatula* de Koninck].

The three American Pennsylvanian species discussed in the previous paper of this series (3b) thus become *Donaldina robusta* (Stevens), *D. ste-*

vensana (Meek and Worthen) and *D. swallowiana* (Geinitz). Also *Donaldina* should be substituted for the term *Aclisina* except where it is used in the original inclusive sense of de Koninck, and except as used for murchisonid species congeneric with *A. striatula*.

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JOURNAL OF PALEONTOLOGY, VOL. 7, NO. 1, PP. 59–108, PLS. 13–16, MARCH, 1933

OSTRACODES OF THE UPPER PENNSYLVANIAN AND THE LOWER PERMIAN STRATA OF KANSAS: I. THE APARCHITIDAE, BEYRICHIIDAE, GLYPTOPLEURIDAE, KLOEDENELLIDAE, KIRKBYIDAE, AND YOUNGIELLIDAE

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ABSTRACT

Thirty-five species of ostracodes of the families Aparchitidae, Beyrichiidae, Glyptopleuridae, Kloedenellidae, Kirkbyidae and Youngiellidae from the upper Pennsylvanian and the lower Permian strata of eastern Kansas are described, illustrated, and their observed ranges given. Emphasis is placed upon the variation which may occur within a species. The figured ontogenetic series reveal differences other than size between the young and the mature molts. Other illustrations show the amount of individual variation in the ratio of length to height, and a study of species of the genera *Jonesina* Ulrich and Bassler and *Hollinella* Coryell demonstrate the decided variations within a species in definite parts of the carapace that are characteristic of these genera. The new family Youngiellidae is proposed to include the genera *Youngiella* Jones and Kirkbya and *Moorites* Coryell and Billings.

Three new genera are proposed and defined: the Permian genus *Pseudoparaparchites* belonging to the Aparchitidae, and the Permian genus *Beyrichiana* of the Beyrichiidae, and the Pennsylvanian and Permian genus *Knightina* belonging to the Kirkbyidae. The family Kirkbyidae and the genera *Jonesina* Ulrich and Bassler and *Sansabella* Roundy are discussed in some detail, with more concise descriptions given of the other genera. Twenty-one species are new.

INTRODUCTION

The upper Pennsylvanian and the lower Permian strata of eastern Kansas below the Herington limestone are commonly very fossiliferous at the outcrops and contain an abundant microscopic fauna, one of the most conspicuous elements of which is the ostracodes. Collections of the microscopic fauna were made from the Stanton limestone, middle Pennsylvanian, and higher strata up to and including the Herington limestone, which is the highest commonly fossiliferous bed in the Permian of Kansas. Most of the limestones and shales containing numbers of megascopic fossils carry an abundant microscopic fauna, the exception being the Herington limestone and the adjacent Enterprise shale, in which microscopic fossils are exceedingly rare, even where there are many pelecypods.

The following ostracode species, many of them modernized as to generic references, have been described[1] from Kansas:

[1] Ulrich, E. O., and Bassler, R. S., New

Albanella gouldi Harris and Lalicker
Amphissites pinguis (Ulrich and Bassler)
Amphissites centronotus (Ulrich and Bassler)
Amphissites koehleri Delo
Bairdia beedei Ulrich and Bassler
Bairdia crassa Harlton
Bairdia maxeyi Harris and Lalicker
Cypridina subovata Ulrich and Bassler
Cytherella intermedia Jones, Kirkby and Brady.
Glyptopleura spinosa Harlton
Glytopleura irregularis Delo
Glyptopleura triserta Harris and Lalicker
Hollinella nevensis Kellett
Hollinella crassamarginata Kellett
Hollinella gibbosa Kellett
Hollinella shawnensis Kellett
Hollinella digitata Kellett
Hollinella emaciata (Ulrich and Bassler)
Jonesina bolliaformis (Ulrich and Bassler)
Jonesina gregaria (Ulrich and Bassler)
Jonesina alta Harris and Lalicker
Jonesina uncialis Harris and Lalicker
Jonesina papillosa Harris and Lalicker
Jonesina primitioides Harris and Lalicker
Knightina minuta (Harris and Lalicker)
Monoceratina lewisi Harris and Lalicker
Paraparchites humerosus Ulrich and Bassler
Paraparchites inornata (McCoy)
Sansabelloides edmistoni Harris and Lalicker

Of the above species the Kansas forms referred to the Mississippian species *Paraparchites inornata* (McCoy) and to *Bairdia crassa* Harlton are misidentified and are probably new species.

In the present paper those species are to be described which belong to the families Aparchitidae, Beyrichiidae, Glyptopleuridae, Kloedenellidae, Kirkbyidae, and Youngiellidae. Including previously described forms and those to be described in this paper and others now in preparation, approximately one hundred species of ostracodes have been recognized in the Kansas late Carboniferous strata. A table showing the known ranges of these species will accompany a forthcoming paper.

At least two-thirds of these species are new. Those which are not described for the first time nor included in the foregoing list of species have been described from neighboring states by Harlton, Knight, Roth and Warthin, as will be noted in the synonymies. Most, if not all, of the species described from Kansas may be expected from the equivalent strata in adjoining states.

The species near the tentative Permo-Pennsylvanian contact were noted especially to ascertain whether a distinct faunal break could be found. This contact was placed some time ago by the United States Geological Survey and the Kansas State Geological Survey at the base of the Cottonwood limestone, although Beede presented evidence that it should be as low as the base of the Neva limestone. Recently, however, Moore[2] has indicated that this contact should be at the base of the

American Paleozoic Ostracoda, Notes and Descriptions of Upper Carboniferous Genera and Species, *Proc. U. S. Nat. Mus.*, vol. 30, pp. 149–164, pl. 11, 1906.

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Harris, R. W., and Lalicker, Cecil G., New Upper Carboniferous Ostracoda from Oklahoma and Kansas; *Amer. Midl. Nat.*, vol. 13, pp. 396–405, pls. 36–37, Nov. 1932.

[2] Moore, Raymond C., Correlation Chart of Post-Devonian Rocks in Part of the Mid-Continent Region, accompanying the guide book of the fifth annual field conference of the Kansas Geological Society, September, 1931, also in the "Abstracts of papers to be offered at the forty-fourth annual meeting of the Geological Society of America," December, 1931, p. 66.

Americus limestone which is below both of the other horizons. The ostracodes show practically no evidence of a faunal break between the Americus limestone and the higher Neva or Cottonwood limestones, most of the species in the Americus limestone extending up through the Neva limestone into the Cottonwood limestone. There is perhaps a little more evidence for a change in the ostracode fauna coming at the base of the Americus limestone, but the transition from the forms of the Shawnee group to the typical Permian fauna is gradual, no one horizon being marked by the disappearance of a number of old species and the introduction of several new ones.

Some of the species are extremely long-ranging. Several even extend with seemingly no change from the Marmaton into the Permian. However, a number are limited vertically to a range of several hundred feet, and a few to quite narrow zones. Altogether it would seem that with intelligent use ostracodes do have stratigraphic significance in the Mid-Continent Pennsylvanian and Permian.

VARIATIONS WITHIN SPECIES

Amongst the specimens of many species and genera to be described are found many specimens that are quite small and which are undoubtedly young individuals or molts of the earlier growth stages. Though in some instances the smallest of these differ in other characters than size from the larger examples and might easily be taken for different species, they so intergrade that it is quite evident that they may be arranged in ontogenetic series. A number of these ontogenetic series are figured with the smallest specimens placed at the bottom and the larger progressively above them. These series show in nearly every species that the young are in lateral view more sharply pointed anteriorly than the mature examples. Many species show little variation other than this change in outline and the variation in size between the valves of different molts, but some show other differences. The smallest specimen of *Amphissites pinguis* (Ulrich and Bassler), Plate 15, figures 12–22, might well be taken for another species were there not intergrading forms to make apparent the decreasing prominence of the central and the antero-cardinal nodes accompanying an increase in the size of the carapace.

No claim is made that these series as figured represent each molt of the animal or that the same molt may not be represented more than once. Thus, in the series showing *Amphissites pinguis*, eleven specimens ranging from the smallest to the largest are shown. The three largest may, and probably do, represent fully matured adults, the differences being merely individual. Such duplication of molts may or may not occur in other cases or certain molts of a series may be missing. There is no precise means of distinguishing each molt, as they form a gradually changing series. It seems probable, however, from the figured specimens mentioned above, that the individuals of the

species *A. pinguis* must have undergone at least six molts, a number of molts apparently equaled or nearly equaled by many other Kirkbyidae.

Attention is also called to the variation in the ratio of length to height within a species displayed by some of the figured specimens of the Kirkbyidae, for instance on Plate 15, figs. 1 and 2, 33 and 34, and Plate 16, figs. 16 and 17. It will be seen that this variation is considerable. In the Kirkbyidae this variation does not cause confusion because there are present in members of this family distinctive surface features such as nodes, ridges, flanges and pits upon which specific determinations may be based with reliance. However, in *Bairdia*, *Cytherella* and *Bythocypris* where such ornamentation is lacking, and in the very simply ornamented *Healdia*, an even slighter difference in this ratio is alone often given as sufficient reason for specific differentation. The variations within the easily distinguished species of the Kirkbyidae demonstrate that a considerable latitude in the ratio of length to height should be allowed within many species of fossil ostracodes. This difference seems to be due to individual and perhaps in some genera to sexual variation, and partly to deformation, either while living or after death. That valves may be considerably deformed without cracking or breaking is made clear by the fact that brachiopod spines have been removed from the exterior of valves where they left trough-like depressions with smoothly rounding edges, as though the valves were plastic under the condition of burial. This does not mean that great care should not be exercised in discriminating species, because many valid distinctions are based upon characteristics which are much less noticeable upon first glance than the ratio of the length of a valve to its height.

Mention should be made of certain variations within a species which are characteristics of the genus to which the species belongs, and which will be found also in the other congeneric species. A variation within the species of a certain part of the carapace may be characteristic of all the species of one genus, and in a second genus a variation in another part of the carapace may be equally as characteristic of the species belonging to this second genus. For instance, in the following discussion of the genus *Jonesina* Ulrich and Bassler, evidence is presented to demonstrate that in most species of *Jonesina* a noticeable variation occurs within each species in the tumidity of the anterior portion of the carapace. To illustrate further, great variations of the width of the frill are displayed within each species of the genus *Hollinella*.

The numerous kinds of variations noted above are often confusing in the separation of new or unfamiliar species. However, a knowledge of the kind and the amount of variation to be expected within certain groups, and a sufficient number of specimens to exhibit intergrading forms of the species, will enable fine yet valid specific distinctions to be drawn. It is

becoming increasingly apparent that the modern tendency toward fine discrimination of closely related species must be based on studies of as large a number of specimens as possible if we are properly to evaluate individual as distinct from specific variation and to avoid the pitfalls of over-naming. This is particularly true for species with little or no distinctive ornamentation.

ACKNOWLEDGMENTS

This study of Kansas ostracodes was undertaken at the suggestion of Dr. J. Brookes Knight and commenced at the University of Kansas in 1928. I am Dr. Knight's debtor for advice and help throughout the work. The latter part of the study has been done in the laboratories of the Amerada Petroleum Corporation, executives of which have my best thanks for permitting the publication of not alone the descriptions, but also the known ranges of the fossils. I wish also to express my thanks to Dr. Raymond C. Moore, to Dr. Walter A. Ver Wiebe, to Mr. Anthony Folger and to Miss Olive Hoffman for advice in collecting.

In the register of fossil localities given at the end of this paper Moore's recent revision[3] of the upper Pennsylvanian and lower marine Permian has been followed in making the broader stratigraphic divisions, especially in placing the Permo-Pennsylvanian contact at the base of the Americus limestone. The Nebraska Geological Survey,[4] as well as Moore, gives formational rank to the former Garrison shale member, Wreford limestone member and Winfield limestone member.

The term cyrioplesiotype, coined by Knight,[5] is used in the following descriptions "to designate the principal or typical specimen among several plesiotypes."

The illustrations have not been retouched except in two or three cases where extraneous matter was erased. It is hoped that any loss of distinctness in the photographs will be more than compensated for by accuracy. Before being photographed many of the figured specimens were whitened with a film of ammonium chloride by the method described by Ulrich and Bassler.[6]

The types and figured specimens are deposited in the United States National Museum. Additional paratypes and plesiotypes of most of the described species have been placed in the collections of the University of Kansas, Lawrence, Kansas; of the University of Oklahoma, Norman, Oklahoma; of the University of Chicago, Chicago, Illinois; and of Columbia University, New York City.

SYSTEMATIC DESCRIPTIONS

Family APARCHITIDAE Ulrich and Bassler, 1923

Genus PARAPARCHITES Ulrich and Bassler, 1906

Paraparchites Ulrich and Bassler, *1906*, Proc. U. S. Nat. Mus., vol. 30, pp. 149, 150.

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[3] See footnote, page 60.

[4] Condra, G. E., and Upp, J. E., Correlation of the Big Blue Series in Nebraska, *Neb. Geol. Survey*, Bull. 6, (2) Dec., 1931, p. 13.

[5] Knight, J. Brookes, *Jour. Pal.*, vol. 4, Supp. 1, Dec. 1930, p. 27.

[6] Ulrich, E. O., and Bassler, R. S., *Maryland Geol. Surv.*, Silurian vol., 1923, p. 283 text fig. 12.

Original description: Carapace small, 1 mm. to 2 mm. in length, leperditoid or subovate in shape; surface smooth, sometimes with a small tubercle or spine in anter-cardinal third of each valve; right valve with ventral edge rabbeted so as to slightly overlap the simply beveled edge of the left valve; dorsal edges of valves usually unequal, the left slightly the more prominent and commonly overlapping the right or receiving its edge in a shallow groove.

Genotype by original designation —*P. humerosus* Ulrich and Bassler.

PARAPARCHITES HUMEROSUS Ulrich and Bassler

Plate 13, figures 1–12

Paraparchites humerosus Ulrich and Bassler, *1906*, Proc. U. S. Nat. Mus., vol. 30, p. 151, pl. 9, figs. 1–4; Elmdale and Wreford formations, Permian, Kansas. Figured specimens from the Elmdale formation, Manhattan, Kansas.

The original description of *P. humerosus* follows:

Length of large example, 1.8 mm.; height of same, 1.25 mm.; thickness of same, 1.05 mm. Carapace subovate, with the outline slightly angulated in the antero-dorsal region; surface rather strongly convex, with greatest thickness near middle of valves. Left valve with dorsal edge straighter than in right valve, the edge in the latter being convex in outline and thickened so that it projects above the hinge line of the left valve. Ventral edge of carapace thick and slightly channeled on each side of a constant line between the valves.

This species is distinguished from all known American Carboniferous species referable to this genus and from those from British rocks described by Jones and Kirkby as of Leperditia, except their *L. compressa*, in the more ovate outline of its carapace. The valves of *L. compressa*, however, are much less convex, especially in the middle parts, so that its carapace presents a very different outline in edge views when compared with the comparatively evenly convex profiles presented in corresponding views of *P. subovata*. In all other Carboniferous Leperditiidae the dorsal line is straighter and one or both of the dorsal angles much better defined.

On account of the thickness of the dorsal edge of the right valve and the rounding of the outline thereby produced, this valve may be mistaken for valves of *Cytherella* like *C. richteriana*, Jones and Kirkby and *C. inflata* Jones and Kirkby.

Formation and locality: Abundant in the Elmdale formation, Manhattan, Kansas, and in the yellow shales of the Wreford limestone, 6 miles west of Reece, Kansas. The species occurs also in forms generally a little inferior in size to the Manhattan specimens, very abundantly in the Permo-Carboniferous deposits of Texas, notably in certain dark shaly limestone, on Mustang Creek, east of Ballinger.

Cotypes: Cat. Nos. 35627, 35657, U. S. Nat. Mus.

This description fits the species here identified as *P. humerosus* in all but one respect; the ventral edges are not channeled as in the above description, but are smooth except for the rather narrow but distinct overlap of the right valve on the left. This overlap is accomplished by means of the beveling on the inside edge of the margin of the right valve, keeping the surfaces of the valves almost flush at their juncture. Although differing from the type of *P. humerosus* in this possibly important characteristic, it would seem that these specimens belong to the species *P. humerosus*, the type very likely being weathered. This conclusion is reached because Ulrich and Bassler state in substance that *P. humerosus* is the abundant *Paraparchites* in the Permian of Kansas, so therefore it seems highly probable that the common and the sole undoubted species of this genus found as yet in the

Permian of Kansas is *P. humerosus*. The statement in the original description of the species that the right valve is more thickened at the hinge than the left is clearly a slip of the pen, because in the description of the genus which has as its genotype *P. humerosus*, the following contrary statement is made: "dorsal edges of valves usually unequal, the left slightly more prominent and commonly overlapping the right or receiving its edge in a shallow groove." The left valves of the specimens that I examined are all thicker and higher at the dorsum than the right valves. No hinge structure could be found on the specimens examined.

The ontogenetic series of *P. humerosus*, Plate 13, figures 1–7, shows that in the side views of this species the anterior part of the valve becomes proportionately higher with age, the antero-ventral margin changing from a straight and oblique line to a broadly rounded arc. A comparison of a young specimen (pl. 13, fig. 7), with the largest and probably oldest specimen shows this difference. It also shows that the thickening of the dorsal edge in the larger specimen has obscured the straight hinge which the smaller specimen with its unthickened edge exposes. Dorsal views (pl. 13, figs. 8–12) emphasize the increasing tumidity of the carapace with age. This tumidity is pronounced only in the central part of the valves. The dorsal outline thus changes greatly with age, being narrow in the small or young specimen, and with increasing size and age becoming more nearly diamond shaped, that is, wide at the center with rapidly tapering ends.

The largest specimen found at Locality 45 had a length of 1.43 mm. Measurements of the largest specimen figured (pl. 13, figs. 1, 8) are: length, 1.17 mm.; height, 0.88 mm.; width, 0.64 mm.

It is doubtful whether the species referred by Delo[7] to *P. humerosus* is really conspecific. The overlap of the left valve appears much too thick in the illustration, but in the description it is stated that the overlap is not conspicuous. The venter of the form figured by Delo appears straighter in side view and the ends a little more broadly rounded than is common in *P. humerosus*.

Found in the upper Pennsylvanian and the Permian. Falls City (?) limestone, upper Wabaunsee group, Pennsylvanian, Loc. 40, 10 specimens; Elmdale formation, Permian, Loc. 62, 1 specimen; common but weathered in the Garrison formation, Loc. 58, 70 specimens; common in the Wreford formation, Loc. 43, 7 specimens; and in the Fort Riley limestone, Loc. 45, 44 specimens. The holotype is from the Elmdale formation, Manhattan, Kansas. Plesiotypes, U. S. Nat. Mus. No. 85423.

PARAPARCHITES MAGNUS Kellett, n. sp.

Plate 13, figures 13, 23, 38, 39

Large and rather high, with little backward swing in side view, antero-dorsal and post-dorsal angles about equally obtuse; greatest thickness,

[7] Delo, David M., *Washington Univ. Studies*, n. ser., *Science and Techn.*, No. 5, p. 42, pl. 4, fig. 1, 1931.

which is one-half of the length, in the middle slightly anterior to the center. Carapace not thickened or flattened at the straight hinge line which is little impressed, with the left valve only faintly, if at all, higher than the right. Overlap of right valve very slight at the ends, especially the anterior, but more prominent ventrally. A coarse tubercle on each valve. Surface probably fairly smooth, the pitted surface of figured specimens due to weathering. Measurements of the holotype (pl. 13, figs. 13, 38) are:

EXPLANATION OF PLATE 13

All figures ×25

FIGS. 1–12—*Paraparchites humerosus* (Ulrich and Bassler), Fort Riley limestone. Loc. 45. Plesiotypes, U. S. Nat. Mus. No. 85423. Figs. 1–7, an ontogenetic series showing the decreasing obliquity of the antero-ventral portion and the rounding of the dorsal profile accompanying increasing size. Cyrioplesiotype, Fig. 1. 1, 2, 4, Right sides carapaces. 3, Single right valve. 5, Single left valve. 6, 7, Left sides carapaces of very young specimens. 8–12, Dorsal aspects of the figured carapaces, the anterior ends to the left. Note the greater tumidity of the larger specimens.

13, 23, 38, 39—*Paraparchites magnus* Kellett, n. sp. Ervine Creek limestone (Deer Creek). Loc. 17. Holotype, U. S. Nat. Mus. No. 85425. Paratypes, U. S. Nat. Mus. No. 85425*a*, *b*. Pitted surface due to weathering. 13, Left side of the holotype. 23, Right side carapace, immature specimen. 38, Dorsal view of holotype. 39, Left side of carapace.

14–16—*Ellipsella* (?) *distenta* Kellett, n. sp., Elmdale formation. Loc. 64, paratype, U. S. Nat. Mus. No. 85431. 14, Dorsal view. 15, Right side carapace; the dark spot at the anterior is due to weathering. 16, Right side carapace tilted to show strong overlap of the left valve at the cardinal angle.

17—*Pseudoparaparchites kansensis* Kellett, n. gen. and sp., single left valve, holotype; Elmdale formation. Loc. 60. U. S. Nat. Mus. No. 85427.

18–20—*Ellipsella* (?) *distenta* Kellett, n. sp., Howard formation. Loc. 25. 18, Dorsal view holotype, U. S. Nat. Mus. No. 85430. 19, Right side holotype. 20, Right valve, paratype, U. S. Nat. Mus. No. 85430 a.

21–22—*Beyrichiana permiana* Kellett, n. gen. and sp., Wreford formation. Loc. 43, Dorsal and side view of left valve, holotype, U. S. Nat. Mus. No. 85428. The dark centered circular spot at the posterior is an attached foraminifera.

24–26—*Cornigella binoda* Kellett, n. sp., Fort Riley formation. Loc. 45. 24, Left valve, paratype, U. S. Nat. Mus. No. 85433a. 25, Right valve, paratype, U. S. Nat. Mus. No. 85433b. 26, Left valve, holotype, U. S. Nat. Mus. No. 85433.

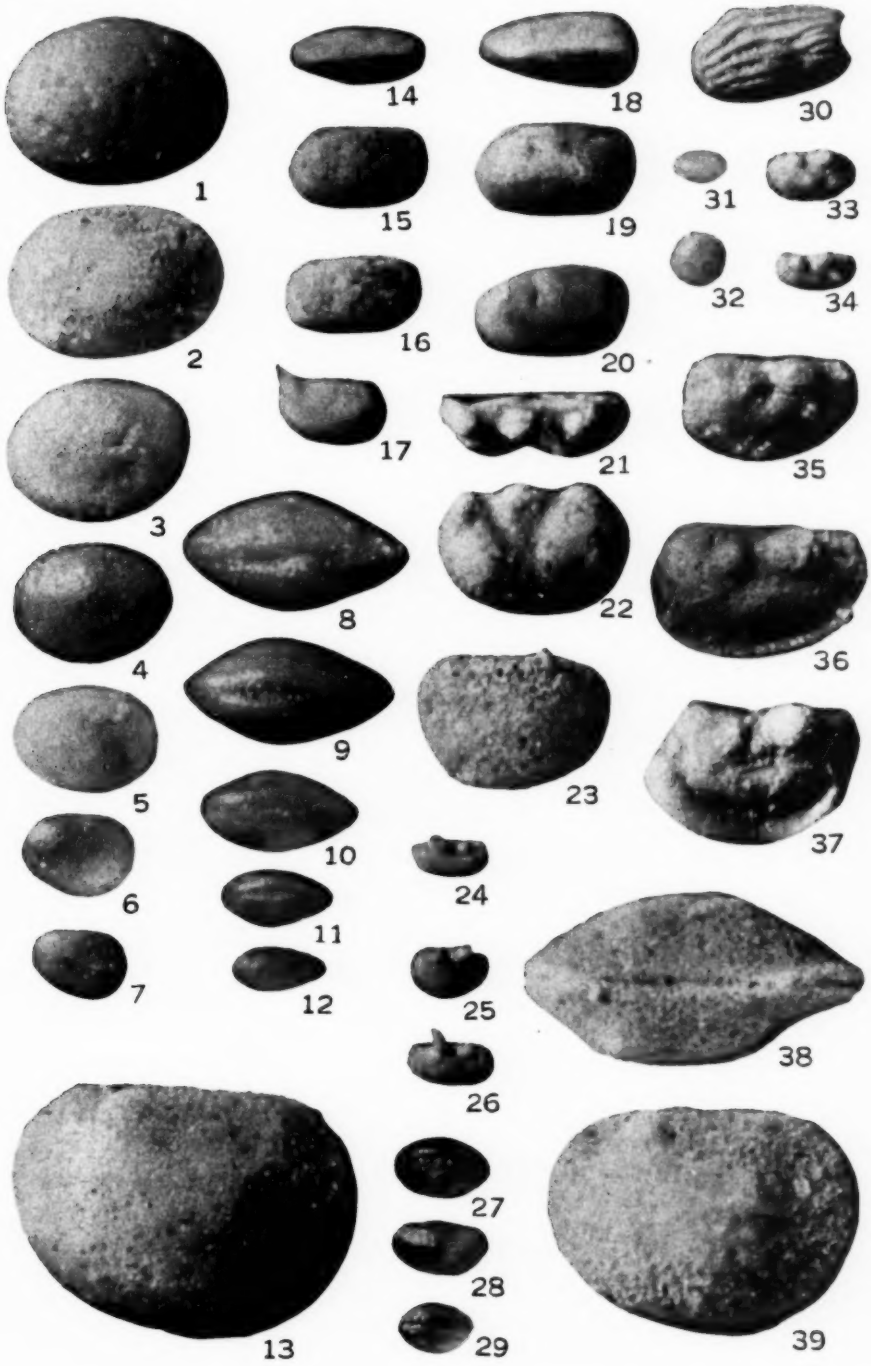
27–29—*Cyathus ulrichi* Roth, Stanton limestone, Loc. 22, U. S. Nat. Mus. No. 85429. 27, Dorsal aspect of cyrioplesiotype, anterior end to right. 28, Right side cyrioplesiotype. 29, Dorsal aspect carapace, anterior end to the right.

30—*Glyptopleura triserta* Harris and Lalicker, single right valve, cyrioplesiotype. Wreford formation, Loc. 43, U. S. Nat. Mus. No. 85426. The dark central spot is adherent matter, and the anterior of the valve is broken.

31, 32—*Paraparchites perminutus* Kellett, n. sp. Iatan (?) limestone, Loc. 24. Holotype, U. S. Nat. Mus. No. 85424. 31, Dorsal view, the anterior to the right. 32, Right side of carapace.

33, 34—*Cornigella parva* Kellett, n. sp., Ft. Riley limestone, Loc. 45, right valves. 33, holotype, U. S. Nat. Mus. No. 85432. 34, paratype, U. S. Nat. Mus. No. 85432a.

35–37—*Hollinella cushmani* Kellett, n. sp., Ervine Creek limestone (Deer Creek), Loc. 18, right valves. 35, Nonfrilled form, paratype, U. S. Nat. Mus. No. 85436a. 36, Narrow-frilled form, paratype, U. S. Nat. Mus. No. 85436b. 37, Wide-frilled form, holotype, U. S. Nat. Mus. No. 85436. The slight ridge running from the anterior of the frill upward toward the anterior node is not a part of the valve but a portion of an attached foraminifera.



Kellett, Pennsylvanian and Permian ostracodes

length, 1.82 mm.; height, 1.30 mm.; width, 0.91 mm.

P. magnus is somewhat similar to *P. humerous* in general outline, but it is twice as large and the post-dorsal angle is not so oblique; in addition it has a large tubercle on each valve. *P. magnus* is narrower and with less backward swing than *P. nicklesi* Ulrich. *P. claytonensis* Knight, which attains the size of *P. magnus*, carries a tubercle on the left valve only. *P. magnus* resembles *P. okeni* as figured by Jones and Kirkby,[8] but the ends are more broadly rounded and the tubercles farther from the hinge.

Deer Creek formation of the Shawnee group, Pennsylvanian, at Loc. 17, 6 specimens; rarer at Loc. 3, 2 specimens; and at Loc. 1, 3 specimens.

Holotype, U. S. Nat. Mus. No. 85425; paratypes, U. S. Nat. Mus. No. 84525 a–c.

PARAPARCHITES (?) PERMINUTUS Kellett, n. sp.

Plate 13, figures 31, 32

Very small, moderately thick ostracodes. Outline in side view roughly circular, the dorsal margin and the upper two-thirds of the posterior margin straight, the remainder of the outline rounded, a slight backward swing noticeable. Dorsal area flattened. Larger specimens of this or of a closely related species from the Marmaton show a distinct indentation of the hinge line within the flattened dorsal area. No apparent overlap. Surface smooth. Measurements of the holotype: length, 0.30 mm.; height, 0.28 mm.; thickness, 0.18 mm.

This minute, high, roughly circular ostracode should be placed in a new genus if it is in reality equivalved. The characteristic overlap of the *Paraparchites* may, however, be present, although indiscernible on so minute a form. *P. perminutus* resembles *P. obesus* (Jones and Kirkby),[9] but it is more nearly circular and lacks the pitted surface of the latter. *P. perminutus* superficially resembles *Entomoconchus scouleri* McCoy, but no trace of the characteristic notch of the genus *Entomoconchus* is present.

Middle Pennsylvanian, Loc. 24, 1 specimen. Also very doubtfully present in the Elmdale formation, lower Permian, at Loc. 60X. Holotype, U. S. Nat. Mus. No. 85424.

Genus PSEUDOPARAPARCHITES Kellett, n. gen.

Small, thin-shelled, straight-hinged ostracodes, with a decided backward swing in side view. Antero-dorsal area marked by a hollow spine with a very large base which is broadly confluent with the surface of the valve, the post-ventral portion of the spine blending smoothly into the central tumid portion of the valve. No hinge or marginal structure apparent except for a thickened band on the interior of the valves along the free edges. This thickening has a width of about one-sixth the height of the valve. Surface unornamented.

[8] *Sci. Trans. Roy. Dublin Soc.*, (2), vol. 16, pl. 11, figs. 8*a–b*, 1896.

[9] Jones and Kirkby, *Ann. Mag. Nat. Hist.*, 5, vol. 18, pp. 249–269, pl. 7, figs. 6*a–b*, 1886.

Genotype, *Pseudoparaparchites kansensis* Kellett, n. sp., Permian

The smooth, straight-hinged specimens of this genus with the prominent dorsal spine resemble members of the genus *Paraparchites* Ulrich and Bassler, but the spine of this new genus is hollow, much broader based and a more integral part of the valve than the spine or tubercle of *Paraparchites*. These genera differ also in hinge and marginal structure, that of *Pseudoparaparchites* being much simpler, with no dorsal depression along the hinge-line and with no apparent dentation or overlap.

PSEUDOPARAPARCHITES KANSENSIS Kellett, n. sp.

Plate 13, figure 17

Very small, thin-shelled, long and straight-hinged, sub-rectangular ostracodes, with a decided backward swing in side view. Greatest height in the posterior one-third. The larger part of the antero-dorsal one-fourth of the valve is occupied by a large hollow spine which has a wide base and is broadly confluent with the surface of the valve which in turn slopes evenly to the edges. The spine tapers to a rather fine point. On the interior of the valves along the free edges is found a thickened band with a width about one-sixth the height of the valve. Only inarticulated valves have been found. Surface smooth. Measurements of the holotype: length, 0.58 mm.; height, 0.34 mm.

Permian and Pennsylvanian. Common in the Elmdale formation at Loc. 60, 6 specimens; rare in the Cottonwood limestone, Loc. 73, 1 specimen. Holotype, U. S. Nat. Mus. No. 85427.

Genus CYATHUS, Roth, 1930

Cyathus ROTH, *1930*, Jour. Pal., vol. 4, No. 4, p. 347.

Carapace very small, canoe-shaped, elongate, and quite tumid, the width being decidedly greater than the height. Carapace broadly ovate in dorsal or ventral view with the posterior half slightly narrower than the anterior. Hinge-line long, straight, and marked by a trough-like depression tapering at the ends, cardinal angles ridge-like and protruding slightly upward. The closed carapace shows a fairly wide shallow depression at the juncture of the free edges of the valves, which depression tapers at each end. This depression is apparently occupied by a portion of the left valve which appears to overlap the edge of the right. Surface obscurely ornamented by fine, parallel, concentric striations, present even on the depressed marginal area.

Genotype by original designation, *Cyathus ulrichi* Roth. McCoy formation, lower Pennsylvanian, Eagle County, Colorado.

C. ulrichi is the only member of this genus known at the present time.

It is not known definitely whether or not this genus should remain in the family Aparchitidae. The cardinal protuberances may indicate highly developed teeth not characteristic of that family. It is difficult to know the exact character of the hinge and marginal structure of *Cyathus* because of the rare occurrence of inarticulated valves.

CYATHUS ULRICHI Roth

Plate 13, figures 27–29

Cyathus ulrichi ROTH, *1930*, Jour. Pal., vol. 4, pp. 347–48, pl. 28, figs. 5–8, McCoy formation, lower Pennsylvanian, Eagle County, Colorado.

Measurements of the cyrioplesiotype from Kansas (pl. 13, figs. 27, 28), are almost identical with those given by Roth, the only difference being 0.01 mm. in width. Measurements of the cyrioplesiotype: length, 0.52 mm.; height, 0.28 mm.; width, 0.33 mm.

Middle Pennsylvanian, Stanton limestone, Loc. 22, 2 specimens. Plesiotypes U. S. Nat. Mus., No. 85429.

Family BEYRICHIIDAE Jones, Emend. Ulrich and Bassler, 1908

Genus HOLLINELLA Coryell, 1928, emend. Kellett, 1929

Hollina (part) ULRICH and BASSLER, *1908*, Proc. U. S. Nat. Mus., vol. 35, p. 315; KNIGHT, *1929*, Jour. Pal., vol. 2, no. 3, p. 235.

Hollinella CORYELL, *1928*, Jour. Pal., vol. 2, no. 4, pp. 377–378; KELLETT, *1929*, Jour. Pal., vol. 3, no. 2, pp. 196–200; WARTHIN, *1930*, Okla. Geol. Survey, Bull. 53, p. 56; BLAKE, *1930*, Jour. Pal., vol. 4, no. 3, pp. 297–298; KNIGHT, *1930*, vol. 4, no. 4, pp. 417–418.

Basslerina MOORE, *1929*, Denison Univ. Bull., Jour. Sci. Lab., vol. 24, pp. 99–113, pls. 6–8.

Hollites CORYELL and SAMPLE, 1932, Amer. Midland Nat., vol. 13, p. 252, pl. 24, fig. 9. (An early molt of a *Hollinella*)

Carapace semiovate, oblique, straight hinged, essentially equivalved, the beveled inner edge of the right valve carrying the beveled outer edge of the left valve; interior of hinge line of left valve grooved to receive the tapered edge of the hinge of the right valve. The right valve overlaps the left at the cardinal angles. Protuberances or spines mark the cardinal angles of the right valve. On the interior of the cardinal angles are small sockets into which fit the corners of the left valve. The presence of this hinge and marginal structure differentiates the genus *Hollinella* from the genus *Hollina*. Marginal beveling on the left valve bordered by a more or less complete row of minute beads or granules. Surface usually granulose, but sometimes smooth, punctate or tuberculose. The most prominent granules or tubercles are often found in front of the anterior node in a diagonal line running downward and backward. A subcentral vertical sulcus extends from the hinge and is terminated ventrally at approximately the mid-height of the valve by a more or less prominent swelling or ridge, a large lobe or node is immediately anterior to the sulcus near the hinge line and a smaller one posterior to the sulcus, with rarely an additional small lobe or two in the post dorsal quarter. Only in the most primitive species is there a small lobe or ridge near the anterior edge. Each species has three different forms: the first of which carries a wide sub-marginal frill except at the anterior, the second of which has a similar but narrower frill, and the third only a row of granules or spines replacing the frill. The young are always of this latter type, but some of the non-frilled specimens may possibly be the males, as suggested in a previous paper on the genus *Hollinella*.

Genotype by original designation,

Hollinella dentata Coryell, Wewoka formation, lower Pennsylvanian, Seminole County, Oklahoma. Devonian to Permian, hinge and marginal structures not fully developed in Devonian forms.

Since the establishing of the Kansas species, *H. emaciata* (Ulrich and Bassler), *H. nevensis* Kellett, *H. crassamarginata* Kellett, *H. gibbosa* Kellett, *H. shawnensis* Kellett and *H. ulrichi* Knight, two new species have been found and are described in the following pages.

HOLLINELLA ULRICHI (Knight)

Beyrichia ? radiata JONES and KIRKBY, ULRICH and BASSLER, *1906*, Proc. U. S. Nat. Mus., vol. 30, p. 156, pl. 11, fig. 5. Cottonwood shales, 2 miles east of Cottonwood Falls, Kansas.

Hollina radiata (JONES and KIRKBY), ULRICH and BASSLER, *1908*, Proc. U. S. Nat. Mus., vol. 35, p. 315, pl. 42, fig. 18.

Hollina ulrichi KNIGHT, *1928*, new name for *Beyrichia ? radiata* (ULRICH and BASSLER, 1906, not JONES and KIRKBY, 1886), Jour. Pal., vol. 2, p. 237. Permian of Kansas, but not from the Henrietta formation, Pennsylvanian of Missouri.

Hollinella digitata KELLETT, *1929*, new name for *Beyrichia ? radiata* (Ulrich and Bassler, 1906, not Jones and Kirkby, 1886), Jour. Pal., vol. 3, pp. 209–11, pl. 26, figs. 1*a–b*. Cottonwood limestone to Wreford formation, Permian, of Kansas.

Carapace of medium length for the genus. Anterior node very prominent, sub-globular and somewhat constricted at the base; posterior node well defined. Frills rather wide and that of the wide frilled form quite convex posteriorly. Cardinal spines of the right valve and the spine terminating the anterior of the frill quite coarse and long. Surface granulose with scattered finger like papillae. Measurements of figured cyrioplesiotype from the Garrison shale:[10] length, 1.12 mm.; height, 0.60 mm.

In renaming *Beyrichia ? radiata* (Ulrich and Bassler, not Jones and Kirkby) in 1929 (*loc. cit.*), I overlooked the fact that the name *Hollina ulrichi* Knight had been proposed as a new name for the same species. The name *Hollinella digitata* Kellett is therefore a synonym. The forms from the lower Pennsylvanian Henrietta formation, which Dr. Knight figured[11] and which he at that time supposed to be conspecific with the Permian species, are, as I have shown,[12] distinct from it and therefore left without a name. Dr. Knight (personal communication) proposes the name *Hollinella kellettae* Knight mss. for the lower Pennsylvanian species first described by him and designates as the holotype fig. 4a, pl. 31 of the original publication.

Warthin reports the occurrence of the species *H. kellettae* Knight (designated as *H. ulrichi*)[13] and also of *H. ulrichi* Knight (designated as *H. digitata*)[14] in the lower Pennsylvanian of Oklahoma. However, the occurrence of the latter species so low in the section is very doubtful. The spinose specimen from the Holdenville formation is described as having a hemispherical anterior node, in which it differs from the Permian form. For the anterior node of the typical *H. ulrichi* from the Permian

[10] Kellett, B., *Jour. Pal.*, vol. 3, 1929, pp. 209–11, pl. 26, figs. 1*a–b*.

[11] Knight, J. B., *Jour. Pal.*, vol. 2, p. 237, pl. 31, figs. 4*a–b*.

[12] Kellett, B., *Ibid.*, p. 210.

[13] Warthin, Aldred S., *Okla. Geol. Surv., Bull.* 53, 1930, p. 56, pl. 4, figs. 6*a, b*.

[14] *Ibid.*, p. 57, pl. 4, fig. 5.

of Kansas is more nearly spherical than hemispherical, is sometimes very moderately constricted at the base, and altogether seems to be more conspicuous than the anterior node of the species described by Warthin. As the species *H. ulrichi* is now restricted, the identification of the form from the Graham formation of Menard County, Texas,[15] is somewhat doubtful. It apparently lacks the globular anterior node of *H. ulrichi*, and is too nearly rectangular and elongate for *H. kellettae*.

HOLLINELLA CUSHMANI Kellett, n. sp.
Plate 13, figures 35–37

Carapace short and high for the genus, moderately oblique; nodes of average diameter, low and evenly convex; sulcus rather shallow; frill of the widest frilled form (pl. 13, fig. 37) of medium width and not very convex, not confluent with the general surface of the valves at any point, but separated all along by a slight depression. On the smaller specimen (fig. 35), the frill is replaced by a row of short tubercles. Surface finely granular. Measurements of the holotype (pl. 13, fig. 37): length, 1.09 mm.; height, 0.73 mm.

H. cushmani is distinguished by being shorter and higher than many rather similar species, such as *H. limata* (Moore),[16] and *H. bassleri* (Knight).[17] A comparison of the narrow-frilled forms of *H. cushmani* and *H. bassleri* shows also that the frill of the latter is much narrower and that it extends father up the anterior edge. *H. cushmani* differs from *H. menardensis* Harlton[18] in having nodes of a much smaller diameter, and from *H. recurva* (Moore),[19] *H. gibbosa* Kellett[20] and *H. burlingamensis* Kellett n. sp. in the flatter and less bulbous nodes. It is not so short and flat as *H. grahamensis* (Harlton),[21] and lacks the thickened posterior extension of the frill which is the distinguishing feature of *H. crassamarginata* Kellett.[22] It is not so rectangular as *H. pulchra* (Moore),[23] and the sulcus seems to be much wider in the Kansas form. *H. cushmani* is very near *H. shawnensis* Kellett,[24] which occurs stratigraphically just above it, but the frill is not confluent with the general surface of the valves at the post-ventral angle, and the top of the anterior node does not have the slight flattening and backward slope characteristic of *H. shawnensis*.

Ervine Creek limestone, Deer Creek formation, Shawnee group, Pennsylvanian, at Loc. 18, 14 specimens. Holotype, U. S. Nat. Mus. No. 85436; paratypes, U. S. Nat. Mus. No. 85436a, b.

[15] Harlton, Bruce H., *Univ. Texas, Bull.* 2901, October 1929, p. 141, pl. 1, fig. 3.

[16] Moore, R. C., *Denison Univ. Bull., Jour. Sci. Lab.*, vol. 24, p. 106, pl. 6, fig. 1; pl. 7, figs. 3, 4; pl. 8, figs. 5, 6, 1929.

[17] Knight, J. B., *Jour. Pal.;* vol. 2, no. 3, pp. 236–240, pl. 31, figs. 1–3; pl. 34, figs. 7, 8, 1928. Kellett, *Jour. Pal.;* vol. 3, no. 2, p. 197, pl. 25, figs. 5*a–c*, 1929.

[18] Harlton, B. H., *Univ. Texas Bull.* 2901, 1929, p. 145, pl. 1, figs. 4, 5, 6.

[19] Moore, R. C., Ibid., p. 111, pl. 6, fig. 2; pl. 7, fig. 7, 8; pl. 8, figs. 9, 10.

[20] Kellett, B., *Jour. Pal.*, vol. 3, no. 2, 1929, p. 207, pl. 25, figs. 3*a–c;* pl. 26, figs. 5–14.

[21] Harlton, B. H., *Ibid.*, p. 145, pl. 1, fig. 7.

[22] Kellett, B., *Ibid.*, 1929, p. 206, pl. 26, figs. 3*a–b*.

[23] Moore, R. C., *Ibid.*, p. 109, pl. 6, fig. 5; pl. 7, figs. 1, 2; pl. 8, figs. 1, 2.

[24] Kellett, B., *Ibid.*, p. 209, pl. 25, figs. 4*a–c*, pl. 26, fig. 8.

The name is in honor of Dr. Joseph A. Cushman of the Cushman Laboratory for Foraminiferal Research.

HOLLINELLA BURLINGAMENSIS Kellett, n. sp.
Plate 14, figures 28–30

Nodes fairly large and quite bulbous, sulcus terminated ventrally by a very short and inflated ridge, almost bulbous in appearance, a ridge so short that it reaches usually less than one-third across the valves. Frills rather wide, and in their widest manifestation (fig. 28) convex.

Measurements of the holotype (pl. 14, fig. 28): length, 1.24 mm.; height, 0.82 mm.

H. burlingamensis is set apart from all other described hollinellids by its short and very inflated ventral ridge, the prominence of which is not fully brought out in the photographs of the type specimens. It is best shown in Pl. 14, fig. 28. In fig. 29 the protruding top of the node has been weathered off, leaving a pit surrounded by upstanding walls. This species is quite like *H. gibbosa* Kellett, for which it was at first taken, until the examination of specimens free from adhering material showed that the inflated ventral ridge was short and terminated abruptly at the ends, instead of very gradually converging with the surface of the valve as in *H. gibbosa*.

Burlingame limestone, Wabaunsee group, Upper Pennsylvanian, Loc. 71, 6 specimens; and in the "Cryptozoan limestone" (Burlingame) of Oklahoma, in the center of the NE quarter, sec. 1, T. 26 N., R. 7 E., stop 9 of the Oklahoma City Geological Society field trip in the fall of 1930, 11 specimens. As a result of work done by Moore and Condra[25] the Burlingame and the "Cryptozoan" limestones are now considered to be equivalent. Holotype, U. S. Nat. Mus. No. 85434; paratypes, U. S. Nat. Mus. No. 85435.

Genus CORNIGELLA Warthin, 1930

Cornigella WARTHIN, *1930*, Okla. Geol. Survey, Bull. 53, p. 59, pl. 4, figs. *7a–c.*

Original description: Carapace minute, subquadrate; greatest height in posterior half; greatest thickness central; hinge-line straight, slightly less than the greatest length of the carapace; valves equal; surface ornamented by about eight prominent spines on each valve, one of which extends well above the hinge-line.

I would extend the limits of the above description slightly to include some forms identical in all respects except that only the two prominent spines near the hinge-line are developed. As Warthin remarks:

> This genus resembles *Mauryella* Ulrich and Bassler in the prominent ornamentation, but lacks the reticulate surface and kirkbyan pit of that group, and is more extreme in the development of the spines

Genotype by original designation —*Cornigella minuta* Warthin. Pennsylvanian, Wetumka formation, Oklahoma.

Specimens of the genus *Cornigella* resemble superficially the Ordovician species, *Tetradella* (*Kiesowia*) *mamillosa* (Krause)[26] in the number and

[25] Moore, Raymond C., Correlation Chart of Post-Devonian Rocks in Part of the Mid-Continent Region, accompanying the guide book of the fifth annual field conference of the Kansas Geological Society, September, 1931.

[26] Ulrich, E. O., and Bassler, R. S., *Proc. U. S. Nat. Mus.*, vol. 35, 1909, p. 307, pl. 39, fig. 11.

arrangement of the nodes, but on the Ordovician species the ventral nodes are more prominently developed than the dorsal nodes, while quite the reverse is true of the genus *Cornigella*.

CORNIGELLA PARVA Kellett, n. sp.
Plate 13, figures 33, 34

This species is more elongate in side view than *Cornigella minuta* Warthin and instead of eight spines has only four or possibly five spines or protuberances, the fifth postero-ventral protuberance being faintly evident on some specimens. The ventral spines of *C. parva* seem to occur nearer the center of the valve instead of farther down as on *C. minuta*. This is probably due to the greater elongation of the valve. Surface rough as if it might be very finely pitted or reticulose. Measurements of the holotype (pl. 13, fig. 33): length, 0.47 mm.; height, 0.26 mm.

C. parva resembles very closely *C. tuberculospinosa* (Jones and Kirkby)[27] from the Mississippian of England, but the post-ventral protuberance of *C. parva* is less well developed and the outline in side view more elongate with less backward swing.

Permian. Fort Riley limestone, Loc. 45, 2 specimens; found in the Winfield formation at Loc. 75, 1 specimen. Holotype, U. S. Nat. Mus. No. 85432; paratype, U. S. Nat. Mus. No. 85432a.

CORNIGELLA BINODA Kellett, n. sp.
Plate 13, figures 24–26

This species differs from *Cornigella parva* only in the number of nodes; the two dorsal nodes alone being developed.

The holotype (pl. 13, fig. 26) has a very elongate finger-like antero-dorsal node or spine, but this spine is not so elongate on all specimens. It is possible that the high specimen (pl. 13, fig. 25) is not conspecific with the narrower holotype (fig. 26) but specimens which seem to intergrade between the two forms occur. It is also possible that *C. binoda* and *C. parva*, which occur together, are conspecific, the absence of the ventral protuberances on *C. binoda* being due to the poor preservation and mashing of the thin valves.

Measurements of the holotype: length, 0.45 mm.; height, 0.23 mm.

Permian. Rare in the Cottonwood limestone, at Loc. 44, 1 specimen; rare in the Wreford formation at Loc. 46, 1 specimen; and fairly common in the Fort Riley limestone at Loc. 45, 15 specimens. Holotype, U. S. Nat. Mus. No. 85433; paratypes, U. S. Nat. Mus. No. 85433a.

Genus BEYRICHIANA Kellett, n. gen.

Sub-ovate, straight hinged ostracodes; in side view with an oblique ventral margin, and a moderate backward swing. Surface of valve quadri-lobate, partially divided by prominent, central Y-shaped system of sulci. Surface granulose.

Genotype, *Beyrichiana permiana* Kellett, n. sp. Wreford formation, Permian, of Kansas.

The single left valve discovered of this distinctive Silurian-like beyrichian resembles closely in the arrange-

[27] Jones, T. R., and Kirkby, J. W., *Ann. Mag. Nat. Hist.*, (5), vol. 18, 1886, p. 258, pl. 8, fig. 8.

ment of the nodes and in the Y-shaped system of sulci specimens of the typically Silurian genus *Beyrichia* McCoy. It cannot, however, be included in that genus or in the somewhat similar genus *Ctenobolbina* Ulrich because the overhanging marginal frill of these earlier genera is lacking. Furthermore, there is no evidence that the female of the Permian species carries the prominent brood pouch characteristic of the genus *Beyrichia* which it most resembles. For these reasons the new genus *Beyrichiana* is established for the reception of the one new species, *B. permiana*.

BEYRICHIANA PERMIANA Kellett, n. gen. and sp.
Plate 13, figures 21, 22

Sub-ovate, rather high ostracodes with a moderate backward swing in side view. Inflated except in the antero-dorsal portion; surface broken up into four distinct nodes or tumid areas by a Y-shaped system of sulci. A small node protrudes above the hinge a little in front of the center of the valve. Sulci on either side of this node converge beneath it and continue as one sulcus obliquely downward and backward almost to the ventral edge, thus almost segregating the inflated posterior part of the valve. Two nodes at the anterior; a small rounded one at the antero-dorsal corner which extends above the hinge, and below this node a larger less nodelike inflation of the antero-ventral portion of the valve. Surface of the valve, except for a very narrow border around the free edges, covered with coarse granules which on the most inflated portions of the figured specimen are obscured by abrasion or by a cement-like covering. This weathering also obscures any dentation that may be present. The circular spot at the posterior of the type is probably the remains of an attached foraminifera. Measurements: length, 1.03 mm.; height, 0.65 mm.

B. permiana looks much like *Beyrichiana* (?) *gigantea* (Jones, Kirkby and Brady)[28] from the Carboniferous of Great Britain. This form, however, appears to lack the well developed antero-dorsal node of *B. permiana*.

Wreford formation, Permian, Loc. 57, 1 specimen. Holotype, U. S. Nat. Mus. No. 85428.

Family GLYPTOPLEURIDAE Girty, 1910

Genus GLYPTOPLEURA Girty, 1910

GIRTY, *1910*, Annals N. Y. Acad. Sci., vol. 20, no. 3, pt. 2, p. 235.

Original description. Shell rather small, subquadrate, with a backward swing, the posterior end being higher than the anterior and somewhat truncated.

Inequivalve; the left valve is much the larger and overlaps the other all around save along the distinct straight hinge. There is a subcentral pit. The surface is marked by inosculating costae.

Genotype by original designation —*Glyptopleura inopinata* Girty.

The type is from the Fayetteville shale of the Mississippian in Arkansas. An interesting statement is made by Girty about this little known spe-

[28] Jones, T. R., Kirkby, J. W., and Brady, G. S., *Paleontographical Soc. Mon., Brit. Carb. Ostrac.* 1884, p. 88, pl. 4, figs. 27*a–c*.

cies which has never been figured: "There is a smooth, finely striated border which surrounds the shell everywhere save along the hinge." These fine striations are figured by Ulrich[29] on another Mississippian species of *Glyptopleura*, but so far have never been noted on any of the Pennsylvanian species described.

Specimens of *Glyptopleura* were rare in the Kansas material examined, and no left valves were found of the one species to be described. However, other species examined from the upper Pennsylvanian and Permian show that the left valve has a triangular flap or tooth at each cardinal angle, which fits over the right valve. The teeth are quite prominent on some species.

Coryell and Blackmier[30] have recently assembled in one paper all of the previously published figures and descriptions of the species of *Glyptopleura* with the addition of several new species.

Delo[31] described two species of *Glyptopleura* from a deep well in western Kansas. The one, *G. irregularis* was a new species, and the other is identified with *G. spinosa* Harlton from the Canyon group of Texas, differing only very slightly from the type.

GLYPTOPLEURA TRISERTA Harris and Lalicker, Plate 13, figure 30

Glyptopleura triserta Harris and Lalicker, *1932*, Am. Midl. Nat., vol. 13, p. 403, pl. 37, fig. 8; Wreford limestone, Permian; Cowley County, Kansas.

A single left valve of this distinctive species was found. The posterior end is perceptibly higher and there is a slight concavity in the post-dorsal outline just below the cardinal angle. A thin, flat, marginal edge, transverse to the plane of juncture of the valves is present except at the hinge and at the posterior margin. Ventrally this thin flat marginal edge is centered by an almost indistinguishable raised line. The uppermost longitudinal costa seen along the dorsal edge of the illustration continues around the posterior and ventral margins just inside of the thin marginal edge mentioned above. The ventral extension of this costa cannot be seen in the illustration. The second longitudinal costa from the top also follows the contours of the dorsal and posterior border and continues around ventrally. It truncates the posterior ends of the four innermost longitudinal costae. Altogether there are eight longitudinal costae, the lowermost one of which does not show in the illustration. About one-third of the distance from the posterior of the second costa from the top a thinning occurs in it which amounts almost to a complete break. This corresponds to a complete break in a similar costa on *G. menardensis* Harlton, and seems to mark a slight depression or sulcus. The feature which reaily distinguished *G. triserta* from all other *Glyptopleura* is the short looplike ridge around the anterior end of one of the central cos-

[29] Ulrich, E. O., *Journ. Cinn. Soc. Nat. Hist.*, vol. 13, 1891, pl. 18, fig. 2a.

[30] Coryell, H. N., and Blackmier, Gladys, The Ostracode Genus *Glyptopleura*, *Am. Midland Naturalist*, Nov. 1931, pp. 505–18. pls. 1, 2.

[31] Delo, David M., *Washington Univ. Studies, n. ser., Science and Techn.* no. 5, Oct., 1931, pp. 44, 45, pl. 4, figs. 4, 5.

tae. The dark circular mass on the ventral half of the figured specimen is extraneous material, and in cleaning it a piece was broken from the rounded anterior of the valve. Measurements: length, 0.88 mm.; height, 0.33 mm.

Wreford formation, Permian, Loc. 57, 1 specimen. Cyrioplesiotype, U. S. Nat. Mus. No. 85426.

Family KLOEDENELLIDAE Ulrich and Bassler, 1923

Genus JONESINA Ulrich and Bassler, 1908

Jonesina, ULRICH AND BASSLER, *1908*, Proc. U. S. Nat. Mus., vol. 35, p. 324, pl. 44, fig. 6–16; *1923*, Maryland Geol. Survey, Silurian, p. 314, text fig. 21, (5). Knight, *1928*, Jour. Pal., vol. 2, p. 241.

Coreylla Harris and Lalicker, *1932*, Am. Midland Naturalist, vol. 13, pp. 397–398, pl. 36, figs. 3a–e. Early molts of *Jonesina bolliaformis* (Ulrich and Bassler).

The genus *Jonesina*, to quote in part the remarks of Knight, is "characterized in its simpler expression by a straight and obscurely denticulate hinge-line, unequal valves, the left being the larger, (and) a primitian sulcus somewhat behind the middle."

Genotype by original designation, *Jonesina fastigata* (Jones and Kirkby), (*Beyrichia fastigata* Jones and Kirkby),[32] Mississippian of Scotland.

The authors in first describing this genus allowed a considerable latitude in the character of the hinge of the included species, some being more or less channeled and denticulate. The original figures by Jones and Kirkby of *J. fastigata* are reproduced by Ulrich and Bassler, unaccompanied, however, by the full description of the figures given by Jones and Kirkby. One of the figures reproduced by Ulrich and Bassler appears to be the right side of a carapace with the overlapping left valve showing plainly at the hinge-line as well as ventrally and at the ends. It was thus interpreted by Roundy.[33] He therefore suggests that the Kansas species *Jonesina bolliaformis* (Ulrich and Bassler) with its channeled dorsum should be removed from the genus *Jonesina* because it differs from the genotype in such an important character, and that it should be placed in the genus *Sansabella* which he had just established. *Sansabella* closely resembles *Jonesina*, but is characterized by an almost completely grooved or channeled dorsum and a hinge structure consisting "of a longitudinal groove and tongue on each valve," the tongue on the left valve being the "upper or dorsal margin of the groove" and on the right valve the tongue is the lower margin. It is not probable that the genotype of *Jonesina* has a dorsal overlap of the right valve, for the original drawing of *J. fastigata* which seems to show this overlap is described by Jones and Kirkby as a "thick-shelled carapace showing *cast* of" right valve (the italics are mine). What has been taken for dorsal overlap is probably only the thickened edge of the left valve showing around the cast of the right. We do not really know the

[32] Jones, T. R., and Kirkby, J. W., *Geol. Mag.*, decade 3, B. 3, 1886, p. 438, pl. 12, figs. 8–10.

[33] Roundy, P. V., *U. S. Geol. Survey, Prof. Paper* 146, 1926, p. 5.

hinge characters of *J. fastigata* because the original descriptions are even less enlightening than the illustrations, making no mention of the hinge characters.

I am retaining for the present in the genus *Jonesina* the Kansas species *J. bolliaformis* Ulrich and Bassler, *J. primitioides* Harris and Lalicker and *J. howardensis* Kellett n. sp., for although all have a channeled or partially channeled dorsum, the groove and tongue characteristic of *Sansabella* is either undeveloped or else is very obscurely developed and present on only one valve. It would probably be well to place in the genus *Sansabella* only those species which are known to have the well developed denticulation as described by Roundy.

The only species of the *Jonesina*-type with definite dorsal overlap which has been described is the form referred by Warthin to *Jonesina texana* Harlton, from which it differs however in the much slighter sulcus, in the general outline, and in the hinge character. The hinge-line of *J. texana* is straight and depressed anteriorly, while that of the Wewoka form is, to quote Warthin,[34] "gently convex," and with decided dorsal overlap. This mis-identified species described by Warthin is so different from both *J. fastigata* and from the Jonesinae found in this country, and also from *Sansabella*, that it should be placed in a new genus.

Most of the species of *Jonesina* of which specimens have been found in any number appear to have two distinct forms, the one form in which the anterior one-third of the carapace is much more tumid than in the other form. Thus, associated with the very abundant and long-ranging species of the Kansas Permian, *J. bolliaformis* (Ulrich and Bassler), there occur the specimens which Ulrich and Bassler designated as *J. bolliaformis tumida* and described as follows:

> The form which it is proposed to designate provisionally as above differs from the typical variety of the species in two particulars, (1) the outline is somewhat rhomboidal, the anterior border being oblique, beginning to curve backward just beneath the anterodorsal angle, and (2) the anterior third of the valve within the rim is much more tumid, this portion of the carapace being indeed decidedly thicker than the posterior part and generally exceeds even the middle thickness. Occasionally, as shown in fig. 10, the antero median node is obsolete.
>
> It is thought possible that this variety may indicate merely a sexual phase of *G. bolliaformis*. Supposed female individuals of a number of Silurian and Devonian species of Beyrichia are known, but in these the tumidity is larger and much more sharply defined, and it occurs, not on one of the ends, but always on the ventral side of the valves.
>
> *Formation* and *locality*—Associated with, but apparently never so abundant as, the typical forms of the species in Kansas and Texas.

After eliminating the differences in the naterior obliquity of the two forms discussed above which apparently do not hold true, (compare pl. 14, figs. 1–7, the typical form of *J. bolliaformis*, and figs. 17–19, the tumid form), the two forms are seen to be differentiated only by the degree of tumidity in the anterior third of the carapace. Now this variation

[34] Warthin, A.S., *Okla. Geol. Survey, Bull.* 53, 1930, p. 60, pl. 4, fig. 11.

in tumidity can be observed in most species of *Jonesina*, including *J. primitioides* Harris and Lalicker (pl. 14, figs. 13–16, illustrating the tumid form, and figs. 20–27, illustrating the non-tumid form). According to Knight[35] the same condition is met with in any collection of *J. gregaria*. Therefore it is expected that wherever a number of specimens of any species of *Jonesina* are found, part will be much the more tumid anteriorly.[36]

JONESINA BOLLIAFORMIS (Ulrich and Bassler)

Plate 14, figures 1–8, 17–19, 32–36

Beyrichiella bolliaformis and var. *tumida* ULRICH AND BASSLER, *1906*, Proc. U. S. Nat. Mus., vol. 30, pp. 158–9, pl. 11, figs. 7–11.

Jonesina bolliaformis and var. *tumida* (Ulrich and Bassler), ULRICH AND BASSLER, *1908*, Proc. U. S. Nat. Mus., vol. 35, 1908, p. 325, pl. 44, figs. 1–5.

Sansabella bolliaformis (Ulrich and Bassler), ROUNDY, *1926*, U. S. Geol. Survey, Prof. Paper 146, p. 6.

Coryella stovalli Harris and Lalicker, *1932*, Am. Midl. Nat., vol. 13, p. 398, pl. 36, figs. 3a–c; Garrison shale; Chase County, Kansas.

Original description: Length, 0.87 mm.; height, 0.52 mm.; thickness, 0.35 mm.

Carapace rather elongate subovate, the posterior end wider and more oblique than the anterior; cardinal angles obtuse; ends nearly equal in thickness. Surface of valves with two rounded and not very prominent nodes, subcentrally situated, one on either side of the deep median sulcus; nodes generally connected by a more or less obscure loop; posterior node rather better defined though smaller than the anterior. Ventral part of valves swollen without being definitely ridge-like. Dorsum channeled; ends and ventral edge, especially of the left valve, distinctly rimmed. Ventral edge of left valve overlapping that of the right.

The two nodes with the connecting loop impart an appearance strongly suggestive of species of *Bollia*. The loop is sometimes well defined, but in other examples it is scarcely distinguishable. The species evidently is closely related to *Beyrichia fodicata* Jones and Kirkby and *B. fastigata* Jones and Kirby, but its valves are relatively shorter and margined by a distinct rim, a feature not observed on the British species.

Formation and *locality:* Cottonwood shales, 2 miles east of Cottonwood Falls, Kansas. The same species occurs in the Upper Carboniferous deposits in Baylor and other counties in north central Texas.

Holotype: Cat. No. 35631, U. S. Nat. Mus.

The rimmed condition of the valves mentioned by Ulrich and Bassler is not entirely typical of the species, being indistinct and rarely found. It might be added also that the left valve is somewhat grooved on the free margins to receive the free margin of the right valve which is thinner and apparently smooth.

Besides the binodate form described above there are other forms somewhat smaller and showing a third more or less distinct node just below the anterior node. On even smaller specimens both anterior nodes are more distinct than on the larger forms and are somewhat attenuated. On the very smallest forms these nodes resemble blunt spines. In *J. bolliaformis* there is thus a gradation in the distinctness of the anterior nodes, especially the lower one,

[35] Personal communication.

[36] For an explanation of the difference in tumidity within species of *Jonesina*, see Geis, H. L., *Jour. Pal.*, vol. 6, June 1932, pp. 149–188, pls. 22–26. Geis reverses the usual orientation of *Jonesina*, points out the differences in the posterior (as orientated by him) tumidity within several species and suggests that it is a sexual variation. His orientation of *Jonesina*, *Sansabella*, and *Glyptopleura* greatly simplifies the interpretation of the differences in tumidity, and it may therefore be the correct orientation for these genera.

corresponding to the gradation in size. The carapace (pl. 14, fig. 1), is a typical form as described by Ulrich and Bassler. The specimen just below it shows faintly the lower anterior node, as well as the plainly visible antero-dorsal node, while in figures 5–8, 33, 35 and 36 both anterior nodes are plainly visible.

The inclusion of *J. bolliaformis tumida* Ulrich and Bassler as a typical member of the species rather than a variety is explained in the last part of the generic description of *Jonesina*.

Measurements of the cyrioplesiotype (pl. 14, fig. 1): length, 0.77 mm.; height, 0.44 mm.

Upper Pennsylvanian and Permian. Lowest occurrence in the Wabaunsee group: Burlingame limestone, Loc. 71, 2 specimens; rare in the Wakarusa limestone, Loc. 15; and the Falls City (?) limestone, Loc. 40, 13 specimens. Found commonly in the Permian: Americus limestone, Loc. 70, 21 specimens; Elmdale formation, 57 specimens, Loc. 60, 60X, 41, 41A; Neva limestone, Loc. 66, 3 specimens, and 67, 22 specimens; Cottonwood limestone, Loc. 44, 125 specimens; and 73, 20 specimens; Garrison formation, Loc. 59, 100 specimens; Wreford formation, Loc. 43, 4 specimens; Loc. 57, 12 specimens; Loc. 47, 61 specimens; and Loc. 46, 5 specimens; Fort Riley limestone, Locs. 45, 165 specimens, and 77, 3 specimens; Winfield formation, Locs. 56, 1 specimen, and 75, 22 specimens. 619 specimens found altogether. Plesiotypes, U. S. Nat. Mus. No. 85437 and No. 85438.

Jonesina primitioides Harris and Lalicker
Plate 14, figures 13–16, 20–27.
Jonesina primitioides Harris and Lalicker, *1932*, Am. Midl. Nat., vol. 13, p. 401, pl. 37, fig. 2; Neva limestone, Greenwood County, Kansas.

Carapace subrectangular and only slightly elongated; greatest thickness in the center of the valves, except in the young, when it is more toward the venter, a tendency observed also in *J. bolliaformis*. Overlap of right valve by left slight but distinct, there being very little overlap at all at the posterior margin. The free edge of the left valve is thickened in a narrow line on the largest specimens, and there is sometimes a raised line near the margin of the right valve outlining the overlapping edge of the left valve. Hinge-line depressed slightly in the anterior half. No hinge structure could be observed on the thin edges of the valves. A short sulcus, sometimes so slight as to be almost indiscernible, is the only surface feature. Surface smooth.

Associated with the typical form (pl. 14, figs. 20–27) described above is a form (pl. 14, figs. 13–16) which differs only in being more tumid, especially in the anterior one-third. It sometimes attains a larger size than the less inflated form, and although quite abundant does not seem to occur in the smallest sizes. This tumid form of *J. primitioides* is considered conspecific with the thinner form, a variation due possibly to sex or age, as is more fully discussed in the foregoing generic description of *Jonesina*.

Measurements of the holotype (pl. 14, figs. 21, 22): length, 0.71 mm.; height, 0.41 mm.; width, 0.33 mm.

J. primitioides resembles *Jonesina* (?) *tatei* (Jones)[37] from the Mississippian, but the sulcus is not so well developed or long, the sides are more nearly parallel in the Kansas species, and the ventral outline fuller.

[37] Jones, T. R., *Hist. Berwickshire Nat. Hist. Club*, 1863, vol. 5, pp. 81–9, text fig. 3.

EXPLANATION OF PLATE 14

All figures ×25

FIGS. 1–8, 17–19, 32–36—*Jonesina bolliaformis* (Ulrich and Bassler). The figured specimens 1–8, 17, 18 and 36 are from the Wreford formation at Loc. 47, and are plesiotypes, U. S. Nat. Mus. No. 85438. The figured specimens 19, 32–35 are from the Garrison formation, Loc. 59, and are plesiotypes, U. S. Nat. Mus. No. 85437. 1, Right side carapace, cyrioplesiotype. 2, 3, Right side and dorsal view of carapace. 4, 5, Right side and dorsal view of carapace. 6, 7, Right side carapaces. 8, Left side carapace. 17, 18, Left valve tumid form, side and dorsal views. 19, Right valve of tumid form. 32–36. Very young specimens, right sides of carapaces, with the dorsal views, 32 and 34, of the upper two.

9, 10—*Kirkbya firma* Kellett, n. sp., Stanton limestone, Loc. 22, holotype, U. S. Nat. Mus. No. 85441. 9, Dorsal view, anterior end to the left. 10, Left side carapace.

11, 12—*Kirkbya valida* Kellett, n. sp., Elmdale formation, Loc. 64. 11, Left valve, holotype, U. S. Nat. Mus. No. 85442. 12, Left valve, paratype, U. S. Nat. Mus. No. 85442a.

13–16, 20–27—*Jonesina primitioides* Harris and Lalicker. Neva limestone, Loc. 42. Cyrioplesiotype Figs. 21, 22, U. S. Nat. Mus. No. 85440. Figs. 13–16, plesiotypes tumid form; Figs. 20, 23–27, plesiotypes, non-tumid form; U. S. Nat. Mus. No. 85440a-i. 13–16. Tumid form, right sides carapaces and dorsal view of largest specimen. 20, single left valve non-tumid form. 21, Dorsal view cyrioplesiotype anterior end to the right. 22–27, Right sides carapaces, non-tumid forms.

28–30—*Hollinella burlingamensis* Kellett, n. sp. 28, Left valve, wide frilled form, Burlingame limestone, Loc. 71, holotype, U. S. Nat. Mus. No. 85434. 29, Left valve, non-frilled form, "Cryptozoan limestone" (Burlingame), Oklahoma, paratype, U. S. Nat. Mus. No. 85435. 30, Right valve, narrow frilled form, "Cryptozoan limestone" (Burlingame), Oklahoma, paratype, U. S. Nat. Mus. No. 85435.

31—*Kirkbya pergrandis* Kellett, n. sp., Ervine Creek limestone, Loc. 17, left valve holotype, U. S. Nat. Mus. No. 85443.

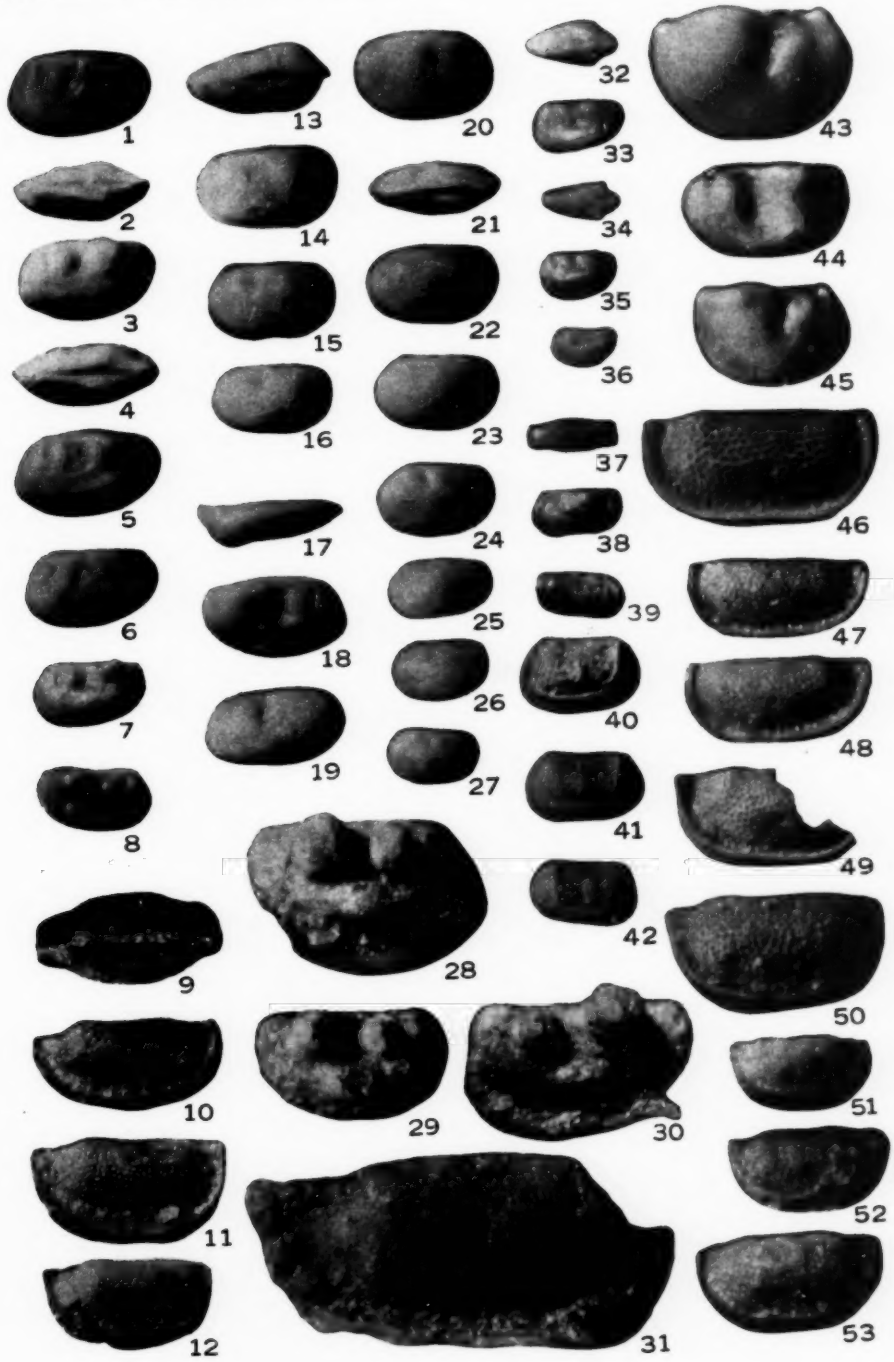
37–39—*Moorites minutus* (Warthin) Cyrioplesiotype, Howard formation, Loc. 25. 37, Ventral view carapace; 38, right side carapace; 39, left side carapace. U. S. Nat. Mus. No. 85447.

40–42—*Amphissites dattonensis* Harlton, Howard formation, Loc. 25, plesiotypes, U. S. Nat. Mus. No. 85453. Cyrioplesiotype, 40; right valves, 40, 41; left valve, 42.

43–45—*Jonesina howardensis* Kellett, n. sp., Howard formation, Loc. 25. 43, Holotype, single left valve, U. S. Nat. Mus. No. 85439. 44, Single right valve, paratype, U. S. Nat. Mus. No. 85439a. 45, Single left valve, paratype, U. S. Nat. Mus. No. 85439b.

46–49—*Kirkbya punctata* Kellett, n. sp. 46, 49, Specimens from the Stanton limestone, Loc. 23; 46, left valve, holotype, U. S. Nat. Mus. No. 85445; 48, right valve, paratype, and 49, left valve, paratype; U. S. Nat. Mus. No. 85445a, b. 47, Right valve paratype, Howard formation, Loc. 25, U. S. Nat. Mus. No. 85446.

50–53—*Kirkbya clarocarinata* Knight, Stanton limetsone, Loc. 22. Cyrioplesiotype, Fig. 50; 50, 53, single right valves; 51, left side carapace with white material filling the circular depressed muscle spot; 52, left valve. Plesiotypes, U. S. Nat. Mus. No. 85444.



Kellett, Pennsylvanian and Permian ostracodes

The tumid form is quite like *Jonesina* (?) *shumardiana* (Girty)[38] from the Yeso formation, but it is not quite so thick and the sulcus is much less prominent.

Abundant in the Neva limestone, lower Permian, at Loc. 42, 144 specimens. Cyrioplesiotype, U. S. Nat. Mus. No. 85440; plesiotypes, U. S. Nat. Mus. No. 85440 a-i.

JONESINA HOWARDENSIS Kellett, n. sp.
Plate 14, figures 43–45

Carapace sub-rectangular and rather high; anterior margin almost straight and perpendicular, ventral margin also straight and paralleling the hinge-line in part, posterior margin showing no great amount of backward swing. Hinge-line long, about four-fifths of the length of the carapace. Antero-cardinal angle usually a right angle, and the post-cardinal angle only moderately obtuse. The cardinal extremities of the left valve are marked by more or less prominent but rather flattened protuberances which partly fit over the corners of the right valve. The left valve conspicuously overlaps the right along the free edges. A raised line on the right valve marks the limit of the overlap by the left. A similar but fainter line is found on the venter of the overlapping left valve at about the same distance from the margin as the line occurring on the right valve. Almost all of the valves of *J. howardensis* found were disarticulated, but it appears that only the anterior two-thirds of the hinge-line is depressed, and that with wide flat sides sloping rather gently. The only hinge structure observed was an indication of a groove on the posterior part of a left valve.

In Plate 14, figs. 43–45, the right valve in the center between the two left valves is seen to be much narrower than either. This is because a thick fold extends downward below the margin of the left venter and is then reflexed sharply up to the margin, forming a sort of a thickened flange which is smoothly confluent with the outer surface of the valve except at the anterior of the venter where a slight marginal flattening may be observed on the exterior. Along the marginal interiors of both valves except at the hinge, runs a thickening or, less likely, an infolding of the edges of the valves about the width of the prominent overlap.

Sulcus long, deep and unusually oblique, the lower end slanting forward. Behind this sulcus is a faint ridge with a slight sulcus near the post-cardinal angle. No definite anterior node is present, but the carapace is thickest in front of the main sulcus near the hinge-line. The upper edge of this anterior fullness is somewhat angular where it is reflexed to meet the hinge. This prominence is sometimes marked, (see pl. 14, figs. 44, 45) by a spine similar to that found on *J. gregaria* Ulrich and Bassler. At locality 30 a fine, small spine on some specimens partly replaced the thick protuberance at the antero-cardinal angle. The surfaces of the figured specimens are quite smooth, but this is believed to be due

[38] Girty, *U. S. Geol. Survey, Bull.* 389, 1909, pp. 41–120, pl. 8.

to peculiar preservation or to exfoliation, other valves showing a finely pitted or reticulate surface. Measurements of the holotype (pl. 14, fig. 43): length, 1.09 mm.; height, 0.73 mm.

J. howardensis is nearest *J. gregaria* but is higher, has an oblique and more prominent sulcus and an angular rather than a rounded appearance.

Common in the Howard formation, lower Wabaunsee group, Pennsylvanian, at Loc. 25, 34 specimens; and just above in the Scranton formation at Loc. 30, 36 specimens. This fossil is believed to have a longer range in Oklahoma than in Kansas, occurring both higher and lower in the section. Holotype, U. S. Nat. Mus. No. 85439; paratypes, U. S. Nat. Mus. No. 85439a, b.

Genus ELLIPSELLA Coryell and Rogatz, 1932

Ellipsella Coryell and Rogatz, *1932*, Am. Midl. Nat., vol. 13, pp. 390–391, pl. 36, figs. 7–10 (explanations of figures on page 394)

Original description in part: "Carapace small, smooth, subquadrangular; right valve larger, producing hingement which overlaps the left valve at the posterior cardinal angle and anterior dorsal slope, forming dentitions at these points."

Genotype by original designation —*Ellipsella obliqua* Coryell and Rogatz. Clearfork group, Permian, Texas.

The Kansas ostracodes referred to this genus agree in all essentials with the generic description except for the presence of an obscure sulcus on part of the Kansas forms. The orientation given by Coryell and Rogatz, which is probably correct, is the reverse of that followed in this paper.

Although *Ellipsella* is here placed in the Kloedenellidae it might well belong in the Glyptopleuridae, the hingement apparently being similar to that of the latter genus.

JONESINA DISTENTA Kellett, n. sp.
Plate 13, figures 14–16, 18–20

Carapace sub-rhomboidal in side view, the dorsal and ventral sides parallel and the angles rounded. In a typical, mature specimen (see pl. 13, fig. 18) the greatest thickness is in the center of the valve at the anterior. The ventral half of the valve is thick, with a rapid thinning in the post-dorsal quarter toward the post-cardinal angle. The left valve overlaps the right strongly at the cardinal angles; this overlap is very prominent at the post-cardinal angle. There is a slight groove along the anterior part of the hinge-line, with perhaps the left valve extending a little above the right. Between this groove and the post-cardinal overlap of the left valve is a short space along the hinge where the valves meet evenly without any overlap or depression. Along the free edges the left valve overlaps the right so little in fact that the valves of many specimens appear practically equal. Ventrally the outside of the free edge of the right valve is distinctly beveled to take the free edge of the overlapping left valve. At the anterior this beveling of the right valve with the consequent overlap of the left is very slight, and it is

lacking at the posterior where the edges meet evenly with no overlap. A more or less obscure, short, narrow, vertical or somewhat cresentic dorsal sulcus is developed well behind the center of the valve. On the right valve (pl. 13, fig. 20) this sulcus has its maximum development; on other valves it is practically indiscernable. Occurring along with the typical members of this species (pl. 13, figs. 18–20) are other specimens which differ in the lack of the extreme anterior inflation. These specimens (see pl. 13, figs. 14–16) are sometimes smaller and usually the sulcus is less well developed. The same sort of variation in the anterior inflation, probably within the species, has already been noted as occurring in the species *J. bolliaformis* (Ulrich and Bassler) and *J. primitioides* Harris and Lalicker, and is reviewed more fully in the generic discussion of *Jonesina*. Dimensions of the holotype (pl. 13, figs. 18–20): length, 0.85 mm.; height, 0.48 mm.; width, 0.39 mm.

E. (?) *distenta*, in outline and in the shape of the valves, except for being a little shorter, it is quite like *Cytherella* (?) *murchisoniana* Jones and Kirkby,[39] a species which does not appear to be a true *Cytherella*.

Pennsylvanian and Permian. Rare, Stanton (?) limestone, Middle Pennsylvanian, Loc. 21B, 2 specimens; Ervine Creek limestone, Loc. 18, 1 specimen (?); common, Howard formation, Loc. 25, 24 specimens; Wakarusa limestone, Loc. 15, 5 specimens; Americus limestone, Loc. 70, 6 specimens; Elmdale formation, Locs. 60X, 2 specimens, and 64, 9 specimens; rare, Neva limestone, Loc. 67, 1 specimen; rare, Wreford formation, Loc. 47, 1 specimen; rare, Fort Riley limestone, Loc. 77, 1 specimen; rare, Winfield formation, Loc. 75, 1 specimen. Holotype, U. S. Nat. Mus. No. 85430; paratypes, U. S. Nat. Mus. No. and No. 85430a, 85431.

[39] Jones and Kirkby, *Ann. Mag. Nat. Hist.* (4), vol. 15, 1875, pp. 52–58, pl. 6, figs. 13*a*–14*c*.

Family KIRKBYIDAE Ulrich and Bassler, 1923

Ulrich and Bassler note that this family is "a most variable and probably unnatural association of equivalved genera." However, if we were to discard from this family *Youngiella*, which has a hinge structure totally different from *Kirkbya*, and also remove *Macronotella* and the very doubtful *Moorea*, there would be left the little known genus *Strepula* and five genera known to be closely related in the common possession of similar hinge and marginal structure, kirkbyan pit, reticulated surface, and homologous nodes. These are the genera *Kirkbya*, *Amphissites*, *Ulrichia*, *Mauryella* and *Knightina*, n. gen., which seem to form a natural unit.

Ontogenetic series in the genera *Kirkbya*, *Amphissistes* and *Knightina* show that ordinarily the small or young of a species are much narrower anteriorly than the mature specimens, which latter are commonly of almost equal width at both ends. In the series of *Amphissites pinguis* (Ul-

rich and Bassler), (pl. 15, figs. 12–22) and of *A. centronotus* (Ulrich and Bassler) (pl. 16, figs. 16–22) the narrow anterior of the smallest specimen may be compared with the wider anterior of larger specimens. *Amphissites dattonensis* Harlton, as figured by Harlton,[40] and also as figured in this paper (pl. 14, figs. 40–42) show the more oblique and narrow anterior of the smaller specimens. This tendency may also be observed in *Kirkbya* in the figures of *K. canyonensis* Harlton (pl. 15, figs. 1–7) and in the series of *K. wymani* Kellett, n. sp. (pl. 15, figs. 23–32). The six species of *Knightina* in Plate 16 almost all illustrate the increase in the height of the anterior end with age.

These ontogenetic series reveal the increased size of the reticulation meshes on the larger Kirkbyidae. Furthermore, the anterior shoulder or node seems always to be at least as prominent and in some cases more prominent on the young individuals, which may mean that this feature was well developed early in the history of the Kirkbyidae.

Genus KIRKBYA Jones, 1859, emend. Knight, 1928

Kirkbya JONES, *1859*, Trans. Tyneside Nat. Field Club, vol. 4, pp. 129, 134, 136.—KNIGHT, *1928*, Jour. Pal., vol. 2, no. 3, pp. 246–252.—ROTH, *1929*, Publ. Wagner Free Inst. Science, vol. 1, pp. 3–14.

Straight-hinged Kirkbyidae with angular cardinal extremities, elongate in side view. Hingement consisting of a more or less prominent ridge on the left valve fitting into a groove on the right. In some species there are cardinal teeth on the left valve fitting into cardinal sockets on the right. Free edge of left valve with the slight inside beveling overlapping the outside edge of the right. Two or more sub-marginal flanges are usually present. These come together near the cardinal angles. Surface commonly ornamented by more or less prominent and distinct nodes or ridges, the most persistent and prominent of which is the antero-dorsal "shoulder." A subcentral "pit" or muscle spot is present, the shape of which is usually of specific value. Surface reticulate.

Genotype by subsequent designation—*Kirkbya permiana* Jones, (*Dithyrocaris permiana* Jones). Permian, Great Britain.

The author follows the revisions of Knight and Roth in regard to the orientation and the hinge and marginal structure, and their papers should be consulted for a more complete discussion of the Kirkbyidae.

The genus *Kirkbya* was proposed by Jones[41] specifically for the reception of *Dithyrocaris permiana* Jones and this species has since been designated[42] as the genotype. Roth, in his revision of the genus *Kirkbya*, recognized that Jones' conception of *K. permiana* included what are undoubtedly many species and in order to define the genus better attempted to designate from Jones' illustrations of 1859, if not a holotype, two syn-

[40] Harlton, Bruce H., *Univ. Texas Bull.* 2901, 1929, p. 149, pl. 1, figs. 9*a–b*.

[41] Jones, T. R., in King's *Monograph of Permian Fossils*, 1850, pp. 1–253, pp. 60–64, pl. 18, figs. 1*a–d*.

[42] Ulrich, E. O. and Bassler, R. S., *Proc. U. S. Nat. Mus.*, vol. 30, 1906, p. 155.

types.[43] Roth seems to have paid no heed to Jones' original description of *Dithyrocaris permiana* where are figured the only specimens available as types of the species. These specimens are unquestionably distinct specifically from the specimens selected by Roth, though with equal certainty congeneric with it. Hence, Roth's selection of the types for the species *K. permiana* which is, in turn, the type of the genus *Kirkbya*, must, preforce, be set aside and a selection made from the specimens described in the original publication. These are two in number, and as one of them is badly broken, I here designate the specimen illustrated in figures 1a and 1b of plate 18 of the original publication[44] as the holotype.

The specimens erroneously selected by Roth as types for *K. permiana* do not appear to be conspecific with those to which the name was originally applied, and hence must eventually be renamed. The American Pennsylvanian forms identified by Roth, it is believed erroneously, with this now nameless British species seem to be conspecific with the new species *K. punctata* from Kansas described in this paper.

KIRKBYA PERGRANDIS Kellett, n. sp.
Plate 14, figure 31

This species, distinguished by its very large size and almost smooth surface, has more rounded ventral angles than are shown in the photograph of the type in which the edge of the flange is chipped or broken instead of being smoothly rounded as on other specimens. The hinge structure is not well developed and the groove on the dorsum of the right valve could not be found. However, the free edges have the typical rabbetting developed to an even greater extent than would naturally be expected on a large carapace with consequently thicker edges. Slight ridges or raised lines outline each edge of the rabbetting, giving a somewhat groovelike appearance. A well defined anterior shoulder has an abrupt anterior face and gentle posterior slope, with an almost imperceptible node or swelling at both its upper and lower corners. In front of the anterior shoulder there is a wide forward extension of the valve which slopes up gently and converges with the flange. Flange, wide, quite elevated ventrally relative to the plane of juncture of the valves, and on some rather transparent specimens displaying a faint ribbing. This flange outlines a fairly wide, smooth, marginal border which is perpendicular to the plane of juncture of the valves. The flange seems to have the position of the usual "inner flange" of the Kirkbyidae, there being no trace of the "outer flange" which is commonly near the free edge of the valve. The pit could not be located. The surface of the figured specimen is roughened by weathering, but in well preserved specimens the surface is smooth with minute, somewhat elongate and barely perceptible reticulations. Measure-

[43] Jones, T. R., *Trans. Tynside Nat. Field Club*, 1859, vol. 4, pl. 8A, figs. 2*a–e*, 3.
[44] Jones, T. R., in King's *Monograph of Permian Fossils*, 1850, pp. 1–253, pp. 60–64, pl. 18, figs. 1*a–d*.

ments of the holotype: length, 2.39 mm.; height, 1.03 mm.

Occurrence, Pennsylvanian, in the Stanton limestone, Middle Pennsylvanian, at Loc. 22, 8 specimens; and in the Deer Creek formation of the Shawnee group at Loc. 17, 4 specimens, and 3, 8 specimens. Holotype, U. S. Nat. Mus. No. 85443.

KIRKBYA CLAROCARINATA KNIGHT
Plate 14, figures 50–53

Kirkbya clarocarinata KNIGHT, *1928*, Jour. Pal., vol. 2, p. 258, pl. 32, fig. 2; pl. 33. fig. 2; Fort Scott limestone, Missouri, HARLTON, *1929*, Univ. Texas Bulletin 2901, p. 152, pl. 2, figs. 3*a–h*, Canyon, Menard County, Texas.

Carapace rather short and quite inflated midway between the hinge-line and the venter, but sloping smoothly in all directions so that the only indication of a node is a slight swelling in the position of the antero-dorsal shoulder which is elevated above the hinge-line. Dentation not visibly developed. Outer flange of moderate width, ventrally the distance of one or two reticulation meshes from the edge of the valve. It is quite flat, as is often the case with the outer flange and parallels the plane of juncture of the valves. Both this flange and the inner one are non-reticulate. The inner flange is narrow and set well up on the sloping side of the valve so that both flanges are visible in side view. The pit is distinctive, being circular and rather large. Measurements of the largest illustrated specimen (pl. 14, fig. 50): length, 1.15 mm.; height, 0.66 mm.

K. clarocarinata is distinguished from all hitherto described species by its smooth, inflated surface, combined with the visibility of both flanges in side view without upward tilting. It resembles most *K. valida* n. sp., but the latter has a small elongate instead of a circular pit, a more prominent antero-dorsal shoulder, and a wider inner flange.

Middle Pennsylvanian, Stanton limestone, at Locs. 22 and 22B, 12 specimens. Plesiotypes, U. S. Nat. Mus. No. 85444.

KIRKBYA VALIDA Kellett, n. sp.
Plate 14, figures 11, 12

Carapace short and somewhat inflated. The smaller of the two left valves found shows a tooth at the anterior cardinal angle, the posterior angle of this valve is somewhat broken. There is a distinct but rounded antero-dorsal shoulder. The greatest thickness of the valve, however, is in the center and not at the anterior shoulder. An outer flange, and an inner flange of moderate width, which is set well up on the sloping side of the valve so that the outer one is partially visible in side view without tilting. Pit small and elongate oval. Measurements of the holotype (pl. 14, fig. 11): length, 1.03 mm.; height, 0.55 mm.

Occurring with *K. valida* were other specimens of the genus somewhat distorted and apparently more elongate. These unidentifiable specimens may belong to another species, or they may be conspecific, in which case the holotype is the shortest variation of the species.

K. valida is very similar in side view and arrangement of the flanges to *K. clarocarinata* Knight, but *K.*

valida is less inflated, has a much more prominent anterior shoulder, a wider inner flange, is smaller and has a small elongate oval instead of a large circular pit. It is shorter than any of the similar species described by Roth, its length being less than twice its height.

Jones and Kirkby described a form from Carlops as *Kirkbya permiana* (Jones)[45] which is undoubtedly distinct from the type, and from any other named species known to me. This form has similarly arranged flanges and also a pit like *K. valida*, but the anterior is much more oblique than that of *K. valida*.

Lower Permian, Elmdale formation, Loc. 64, 3 specimens, 6 doubtful specimens. Holotype, U. S. Nat. Mus. No. 85442; paratype, U. S. Nat. Mus. No. 85442a.

KIRKBYA FIRMA Kellett, n. sp.
Plate 14, figures 9, 10

Carapace very elongate and tumid, the height and the thickness which are almost equal being approximately half of the length. Antero-ventral margin quite oblique in side view. Hinge-line depressed. Greatest thickness, an elongate swelling midway between the dorsal and ventral margins. Antero-dorsal shoulder well developed but rounded with a gently sloping anterior. Outer flange small or moderately wide, and near the edge of the valve; inner flange moderate in width and set some distance, about four reticulation meshes, away from the outer flange. It is not directly above the outer flange, but more nearly so than the inner flange of *Kirkbya clarocarinata* Knight. In side view only the edge of the outer flange can be seen outlining the inner flange. Pit small and elongate. Measurements of figured specimen: length, 1.00 mm.; height, 0.48 mm.; width, 0.49 mm.

This species and *K. clarocarinata* with which it occurs are both very tumid and look somewhat alike, but *K. firma* is more elongate and has a small, elongate instead of a large circular pit. It resembles the illustration of *K. tumida* Roth, but its surface configuration is simpler than that described by Roth, and the flanges are set widely apart instead of very close together. It is more tumid in dorsal view than either *K. distenta* Roth or *K. punctata* Kellett. *K. firma* is more elongate in side view than *K. varica* Roth. The only difference between *K. firma* and *K. arcuata* Roth in side view is the more oblique antero-ventral outline of the former, but *K. firma* is thicker in dorsal view and the antero-dorsal shoulder is more prominent.

Middle Pennsylvanian, Stanton limestone, at Loc. 22, 2 specimens. Holotype, U. S. Nat. Mus. No. 85441.

KIRKBY PUNCTATA Kellett, n. sp.
Plate 14, figures 46–49

Kirkbya permiana (Jones), ROTH, *1929*, Publ. Wagner Free Inst. Science, vol. 1, p. 21, pl. 1, figs. 5*a–b*. Belle City formation in the S.W. corner of Sec. 34, T. 5 N., R. 6 E., Pontotoc County, Oklahoma.

Carapace fairly elongate, cardinal teeth faintly developed. The large

[45] Jones and Kirkby, *Ann. Mag. Nat. Hist.*, (5), vol. 15, 1885, pp. 174–191, pl. 3, fig. 1.

specimen (pl. 14, fig. 46) is almost rectangular in side view, the sides being for the most part parallel, while the smallest specimens (figs. 47, 48) are somewhat narrower at the anterior. This difference in outline is accounted for as being the usual difference in the antero-ventral margin revealed by mature and immature specimens of Kirkbyidae. The greatest thickness is at the antero-dorsal shoulder. This shoulder is well developed, having on the anterior a rather steeply inclined plane which continues around ventrally toward the posterior and dies out. This inclined plane extends ventrally from just above the pit almost to the inner flange. Above the pit the surface slopes toward the hinge, thus there is an ill defined horizontal ridge along the mid-width of the valves extending from the anterior shoulder and ending at a distance of about one-fifth of the length of the valve from the posterior end. The anterior shoulder and the central ridge are less well developed on the younger specimens. The outer flange narrow and thin, paralleling the plane of juncture of the valves, inner flange almost directly above the outer and separated from it by three rows of reticulation meshes. These meshes extend almost to the outer edge of the outer flange. Inner flange of moderate width, rather erect ventrally, and obscuring the outer except occasionally where the latter is seen protruding at the anterior or posterior. The space between the flanges is much narrower at the anterior than at the posterior ventral angle. Reticulations, as is common in the *Kirkbyidae*, smaller on the younger specimens. A row of coarse reticulation pits outline the inner edge of the otherwise smooth inner flange. Pit depressed, oval and rather short.

Measurements of two of the figured specimens: length (Fig. 46) 1.27 mm., (Fig. 48) 0.99 mm.; height (46) 0.61 mm., (48) 0.45 mm. No specimens of a size larger than Fig. 49 were found in the Wabaunsee group.

This species seems to be the same as that figured by Roth as *K. permiana* from the Belle City limestone of Oklahoma. However, the Oklahoma species does not appear to be conspecific with any of the British forms included in *K. permiana* by Jones and Kirkby. *K. punctata* and the Oklahoma species have the same outline in side view, the same proportionate thickness, and the same oval pits. The outer flange or "first keel" of *K. punctata* is broken from the posterior of the figured specimen (pl. 14, fig. 46), otherwise it could be seen projecting posteriorly from beneath the inner flange as on the specimen figured by Roth. *K. punctata* resembles close the species[46] erroneously selected by Roth as the type of *K. permiana* Jones, but the anterior shoulder of *K. punctata* as shown in dorsal view is not so pronounced and rounded, and the pit of *K. punctata* is less elongate. *K. punctata* is proportionately shorter than *K. varica* Roth, and the arrangement of the flanges is different from that of *K. distenta* Roth.

[46] Jones, T. R., *Trans. Tynside Nat. Field Club*, vol. 4, pl. 8A, figs. 2*a*–3, 3.

Middle Pennsylvanian. Stanton limestone, Loc. 23, 4 specimens; in the Wabaunsee group in the Howard formation, Loc. 25, 3 specimens; and the Burlingame formation at Loc. 71, 5 specimens. Holotype, U. S. Nat. Mus. No. 85445; paratypes, U. S. Nat. Mus. No. and No. 85445a, b; 85446.

KIRKBYA CANYONENSIS Harlton
Plate 15, figures 1–7

Kirkbya canyonensis HARLTON, *1929*, Univ. Texas Bull. 2901, p. 153, pl. 2, figs. 5*a*, *b*. Canyon group, Menard County, Texas.

Carapace rather elongate, sub-rectangular; cardinal teeth and sockets fairly well developed. Greatest thickness in the center of the valve where a thick ridge-like elongate node is located; a second node anterior to it and slightly elevated above the hinge-line; a third node in front of the central node and below and slightly in front of the antero-dorsal node. On the smallest specimens, see plate 15, fig. 7, the two lower nodes are not well developed as individuals but blend into the prominent antero-dorsal node, making one long ridge in the center of the valve which has a slight downward and backward slant. The young, as is usual with the Kirkbyidae, are narrower anteriorly than the mature specimens. Inner flange somewhat narrow, outer flange wider and thus visible in side view extending beyond the inner. On the larger specimens the outer margins of the flanges are non-reticulate. Kirkbyan pit small and elongate, situated below the apex of the central node. Measurements of Plate 15, fig. 1: length, 0.99 mm.; height, 0.49 mm.

Common in the Stanton limestone, Middle Pennsylvanian, at Loc. 22, 16 specimens; and also in the Elmdale formation, Lower Permian, at Loc. 64, 35 specimens; rare in the Neva limestone, Lower Permian, at Loc. 67, 1 doubtful specimen. Plesiotypes, U. S. Nat. Mus. No. 85448.

KIRKBYA MOOREI Kellett, n. sp.
Plate 15, figures 9–11

Carapace sub-rectangular in side view, cardinal angles approximately right angled and ventral angles rounded; anterior end equalling in height or inconsiderably narrower than the posterior. Groove on right hinge wide and set obliquely on the top of the valve, slanting toward the interior, rather than on the inner edge of the hinge-line as is usual. This seems to indicate that the left valve would overlap the right slightly at the hinge as well as on the free edges. No complete carapaces were found, however, and it is possible that the wide groove observed on the hinge of the right valve is merely a surface feature rather than an unusually well developed part of the hingement. There seems to be a short horizontal groove at each end of the hinge on the left valve, at the outer ends of which grooves small but well developed teeth are usually present. The central surface of the valve is occupied by a broadly conical elevation which dips smoothly in all directions and extends to the flange, the ends, and the hinge-line. An exception to this regular dip is found on some of the largest specimens in the two indistinct ridges running ob-

liquely from the apex at the center of the valve to the hinge. There the ridges form two shoulders slightly elevated above the hinge-line. The posterior one of these shoulders can be seen distinctly on the right valve (pl. 15, fig. 9). The shoulders are not present on the smaller valve (pl. 15, figs. 10, 11). Ventral edge of valve bordered by a fairly wide reticulate area, perpendicular to the plane of juncture of the valves, and narrowly tapered approaching the cardinal angles. The prominent flange seen in the illustrations seems to occupy the position of the "inner flange," in the terminology of Knight, and is composed of a row of coarse, closely set, blunt spines. The "outer flange" is represented only by a faint line near the edge of the valves, and is just inside a marginal linear row of fine, closely set teeth or granules. The kirkbyan pit is large, circular, and located (pl. 15, fig. 9) below the apex of the central elevation of the valve, slightly towards the anterior. Surface reticulate. At each cardinal angle of several left valves the tubercles of the flange are much elongated and thickened, forming a coarse spine. It is not known whether or not these spines occur on the right valves. Measurements of the figured specimens: length (Fig. 9) 1.29 mm., (Fig. 11) 1.12 mm.; height (9) 0.70 mm., (11) 0.59 mm.

K. moorei is found in the Wreford formation, Permian, at Loc. 43, 9 specimens. Distorted specimens of

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EXPLANATION OF PLATE 15

All figures ×25

FIGS. 1–7—*Kirkbya canyonensis* Harlton, ontogenetic series, Elmdale formation, Loc. 64; plesiotypes, U. S. Nat. Mus. No. 85448. Cyrioplesiotype, Fig. 1; left valves, Fig. 1, 4, 5, 7; right valves, Figs. 2, 3, 6.

8—*Amphissites* (?) *simplicissimus* Knight. Right valve, cyrioplesiotype, Elmdale formation, Loc. 54, U. S. Nat. Mus. No. 85455.

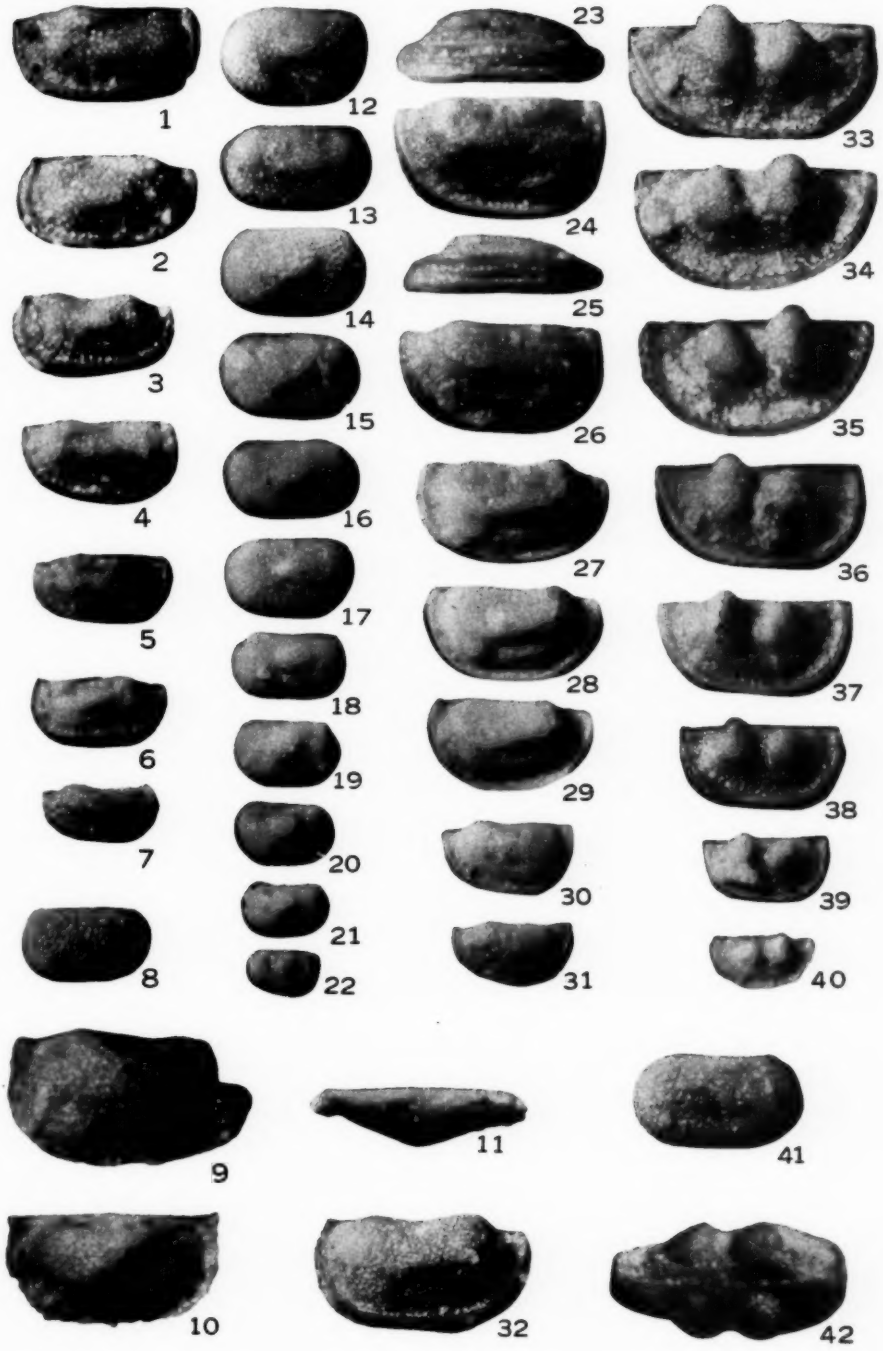
9–11—*Kirkbya moorei* Kellett, n. sp., Wreford formation, Loc. 43. 9, Right valve, paratype, upper corner broken, U. S. Nat. Mus. No. 85452a. Note the large circular depressed kirkbyan pit. 10, 11, Dorsal and side view of left valve, the holotype, U. S. Nat. Mus. No. 85452.

12–22—*Amphissites pinguis* (Ulrich and Bassler). Ontogenetic series from the Cottonwood limestone, Loc. 44; plesiotypes, U. S. Nat. Mus. No. 85456. Fig. 14, cyrioplesiotype; left valves, 12, 13, 17, 19; right valves, 14, 15, 16, 18, 20, 22. Specimens 12 and 13, both probably mature, are figured to show the distinct variation in the ratio of length to height within a species.

23–32—*Kirkbya wymani* Kellett, n. sp. The ontogenetic series, Fig. 23–31, is from the Winfield formation, Loc. 75. The figured specimen 32 is from the Cottonwood limestone at Loc. 73. Note the more oblique antero-ventral angles of juvenile stages. 23, 24, Holotype, ventral and side views, with the anterior end to the left. U. S. Nat. Mus. No. 85450. 25, 31, Paratypes, U. S. Nat. Mus. No. 85450a–g; 25, ventral view, anterior to the left; 26, 30 and 31 are left valves; 27, 28, and 29 are right valves. 32, Right valve, paratype, U. S. Nat. Mus. No. 85451.

33–40, 42—*Ulrichia robusta* Kellett, n. sp. Wreford formation, Loc. 43, Holotype, Fig. 34, U. S. Nat. Mus. No. 85449, paratypes, U. S. Nat. Mus. No. 85449a–g. Left valves, 33, 36, 37, 38. 39; right valves, 34, 35, 40; dorsal view carapace, 42. Note the difference in the ratios of length to height between 33 and 34, both probably mature.

41—*Amphissites pinguis* (Ulrich and Bassler). Left valve, plesiotype, Neva limestone, Loc. 67, U. S. Nat. Mus. No. 85457.



Kellett, Pennsylvanian and Permian ostracodes

what appear to be this species are found in the Neva limestone, Permian, in the center of the east one-half of sec. 28, T. 26 N., R. 6 E, Oklahoma. Holotype, U. S. Nat. Mus. No. 85452; paratypes, U. S. Nat. Mus. No. 85452a.

The name is in honor of Dr. Raymond C. Moore of the University of Kansas and Director of the Kansas State Geological Survey.

KIRKBYA WYMANI Kellett, n. sp.
Plate 15, figures 23–32

Carapace large, sub-rectangular and tumid, thickest in the anterior half of the carapace. Cardinal angles approximately right angles. Hingement with teeth and sockets moderately well developed. Hinge-line slightly depressed with broad almost flat areas on either side. Free edges bordered by a very broad, finely reticulated band, almost perpendicular to the plane of juncture of the valves. This band becomes narrower at the ends and dies out at the cardinal angles. It is much wider at the antero-ventral angle than at the post-ventral angle. The edges of this broad band or border are bounded by smooth and somewhat prominent carinae, and in the center of the border is usually a third rather obscure carina (pl. 15, figs. 23, 25). At the extreme edge of the left valve a fine raised line or carina can usually be seen, while this area on the right is smooth to allow for the overlap of the left valve. A very high but not well defined horizontal ridge runs along the center of the valve, and blends anteriorly with the prominent shoulder elevated above the hinge. The small, oval kirkbyan pit is situated in an elongate, depressed area which lies immediately below the high central ridge and extends forward from the center of the valve to the anterior shoulder. Surface covered with fine reticulations which on the lower half of the valve run in many concentric lines paralleling the border. The juvenile stages show the usual obliquity of the antero-ventral outline in side view.

Measurements of four specimens of *K. wymani* are given, the first two from the Cottonwood limestone and the last two from the Winfield formation. The first specimen is not illustrated, but the others are figured on Plate 15.

	Fig. 32	Fig. 24	Fig. 26	
Length	1.29 mm.	1.15 mm.	1.12 mm.	1.08 mm.
Height	0.67 mm.	0.61 mm.	0.67 mm.	0.58 mm.

The above figures confirm the fact that the specimens of *K. wymani* so far found in the Cottonwood limestone (pl. 15, fig. 32), and the Wreford formation are on the average larger and more elongate than those from the Winfield formation (pl. 15, figs. 23–31).

Permian. Rarely found in the Neva limestone at Locs. 42, 1 specimen, and 67, 1 specimen; common in the Cottonwood limestone, Loc. 73, 19 specimens; in the Wreford formation, Loc. 57, 12 specimens; the Fort Riley limestone, Loc. 77, 15 specimens; and common in the Winfield formation at Locs. 56, 17 specimens, and 75, 13 specimens. Holotype, U. S. Nat. Mus. No. 85450; paratypes, U. S.

Nat. Mus. No. and No. 85450 a–f, 85451.

The name is in honor of Mr. Everett A. Wyman of the Amerada Petroleum Corporation.

Genus ULRICHIA Jones, 1890

Ulrichia JONES, *1890*, Quart. Journ. Geol. Soc. London, vol. 46, p. 543, fig. 2.

Straight-hinged, elongate Kirkbyidae with angular cardinal extremities, the anterior usually the most acute. Left valve having a slight inside beveling and overlapping the beveled outside edge of the right. Hingement consists of a more or less prominent ridge on the left valve and a groove on the right, with the cardinal teeth on the left valve and the corresponding sockets on the right valve, which are characteristic of the family, sometimes well developed. Two large and prominent nodes located on the upper half of the valve are the distinguishing feature of this genus, the anterior one the larger. Pit located near the antero-ventral corner of the posterior node. Two or more well developed flanges present. Surface reticulated.

Genotype, *Ulrichia conradi* Jones. Devonian.

It should be stated that the above description of *Ulrichia* is based on a knowledge of Carboniferous forms, rather than upon the inaccessible genotype. It is possible that this well defined Carboniferous group of Kirkbyidae is not congeneric with the type, *U. conradi* Jones.

ULRICHIA ROBUSTA Kellett, n. sp.
Plate 15, figures 33–40, 42

Ventral edge parallel to hinge, post-cardinal angle usually a right angle and antero-cardinal angle often quite acute. Hinge-line slightly depressed. Hinge and marginal structure typical of the genus, the cardinal teeth and sockets well developed. Nodes large and well developed, somewhat vertically elongate, extending well down to the center of the valve and the larger anterior node extending perceptibly above the hinge-line. Free edges of the valve bordered by a narrow, non-reticulated area, just inside of which is a prominent flange with a smooth, rather flat edge, the upper side of this flange ornamented by one row of reticulations or striations. This flange dies out only at the cardinal angles. Separated from this outer flange by several rows of reticulations is a more prominent inner flange with a wide, smooth edge, and with only one row of reticulations along the inner side of the base. The inner flange varies in width; for instance, in Plate 15, fig. 33, it is narrow, and the free edges of the valve can be seen except in the middle of the venter, but in fig. 34 it is very wide and overhangs the ventral edge considerably. The circular white disc on the right of fig. 34 is a foraminifera which has become cemented to the valve. Just below the nodes is a raised line or carina which dies out near the hinge and can be best seen in fig. 34 of Plate 15. This small carina can only be seen on the larger specimens. The pit can rarely be found, it is probably the smooth oval non-reticulated spot near the antero-ventral corner of the posterior node. Measurements of the

two largest figured specimens are as follows: length (Fig. 33) 1.30 mm., (Fig. 34) 1.30 mm.; height (33) 0.61 mm., (34) 0.64 mm.

U. robusta differs from *U. montosa* Knight in the greater length of the nodes, and also from *U. binoda* Roth and Skinner in this respect. The innermost carina of *U. robusta* does not seem to be so well developed as on this latter species.

Common in the Wreford formation, Permian, at both Loc. 43, 47 specimens; and Loc. 68, 24 specimens. Holotype, U. S. Nat. Mus. No. 85449; paratype, U. S. Nat. Mus. No. 85440 a–g.

Genus AMPHISSITES Girty, 1910, emend. Knight, 1928

Amphissites GIRTY, *1910*, Ann. New York Acad. of Science, vol. 20, p. 235. ROUNDY, *1926*, U. S. Geol. Survey, Prof. Paper 146, p. 7. KNIGHT, *1928*, Jour. Pal., vol. 2, no. 3, pp. 246, 252, 254, 258, pl. 30. ROTH, *1929*, Publ. Wagner Free Inst. Sciences, vol. 1, pp. 31–36; *1929*, Jour. Pal., vol. 3, no. 4, p. 347.

Carapace in side view rather short and sub-rectangular. Ends blunt and of equal height or the anterior slightly the narrower. Cardinal angles obtuse, hinge-line slightly depressed, hingement consisting of a groove in right valve which receives the thin edge of the left, and usually more or less well developed cardinal teeth on the left valve and corresponding cardinal sockets on the right. Left valve, with a slight inside beveling of the free edges overlapping the beveled outside edges of the right. Various nodes and ridges may be present, the most common and prominent of which are the central and the antero-dorsal nodes. Near the free edge of the valve there is commonly an "outer flange" which becomes more or less obscure toward the dorsal angles; converging with this toward the ends and paralleling it at the venter is usually an "inner flange." The inner flange is located, as with all Kirkbyidae, along the line where the surface of the valve is reflexed to be more or less perpendicular to the plane of juncture of the valves. The pit is located near the antero-ventral corner of the central node. Surface reticulated.

Genotype by original designation —*Amphissites rugosus* Girty. Fayetteville shale, Mississippian; Arkansas.

AMPHISSITES DATTONENSIS Harlton

Plate 14, figures 40–42

Amphissites dattonensis HARLTON, *1927*, Jour. Pal., vol. 1, no. 3, p. 206, pl. 32, fig. 9; upper Deese formation, Middle Pennsylvanian, Carter County, Oklahoma. HARLTON, *1929*, Univ. Texas Bull. 2901, p. 149, pl. 1, fig. 9; Canyon group, Middle Pennsylvanian, Menard County, Texas. WARTHIN, *1930*, Okla. Geol. Survey, Bull. 53, p. 64, pl. 4, fig. 15; Wetumka formation, to Holdenville formation, Middle Pennsylvanian, Oklahoma.

Small, short, thin; hinge-line about two-thirds the length of the valve, the cardinal angles consequently very obtuse. Hingement, including teeth, sockets, and grooved right valve, well developed. Free edges of valve bordered by a slight raised ridge or outer carina. Inside of this is a thicker and more prominent inner carina, extending also to the cardinal angles. This inner carina is the one appearing on the figured specimens (pl. 14, figs. 40–42), as bordering the extreme

edges of the carapaces. A third carina extends downward fom the anterior cardinal angle nearly to the ventral edge where it makes an almost right-angled turn toward the posterior, dying out before quite reaching it. On some specimens there seems to be a slight break in this carina at the antero-ventral angle. The central node is small but is crested by a short, prominent vertical ridge. The small pit is located in front of the antero-ventral corner of the central node. Measurements of the two larger figured specimens: length (Fig. 40) 0.64 mm., (Fig. 41) 0.64 mm.; height (40) 0.39 mm., (41) 0.36 mm.

A. dattonensis is differentiated from *A. roundyi* Knight most easily by its more elongate antero-dorsal ridge or carina.

Found only in the Howard formation, lower Wabaunsee group, Upper Pennsylvanian, at locality 25, 24 specimens. Plesiotypes, U. S. Nat. Mus. No. 85453.

AMPHISSITES PINGUIS (Ulrich and Bassler)

Plate 15, figures 12–22, 41

Kirkbya pinguis ULRICH AND BASSLER, *1906*, Proc. U. S. Nat. Mus., vol. 30, p. 159, pl. 11, figs. 13–15; Cottonwood shales, 2 miles east of Cottonwood Falls, Kansas.

Amphissites pinguis (Ulrich and Bassler), DELO, *1931*, Washington Univ. (St. Louis) Studies—n. ser.; Science and Techn.—no. 5, p. 46, pl. 4, figs. *7a–c*. Wood Oil Company, Ranson No. 1 well, Hamilton County, Kansas.

Amphissites gregeri DELO, *1931*, *ibid.*, p. 48, pl. 4, figs. *8a–c*. Wood Oil Company, Ranson No. 1 well, Hamilton County, Kansas.

Cythere? haworthi Ulrich and Bassler, *1906*, *Ibid.*, p. 160, pl. 11, fig. 12. Cottonwood shales, 2 miles east of Cottonwood Falls, Kansas.

Carapace sub-rectangular, short, thick and with rounded corners, antero-cardinal angle more oblique than the post-cardinal angle. Hinge-line impressed. A narrow non-reticulate border around the free edges. Outer flange represented, except at the posterior where it is absent, by a thin raised line inside the non-reticulate border. Surface smoothly curved, broken only by an antero-cardinal shoulder which has an abrupt anterior face but rounds smoothly into the surface behind it. Central node fairly large, but very low and ill defined. The small elongate kirkbyan pit, pointing obliquely upward toward the front is impressed on the lower side of and slightly anterior to the central node. Surface neatly reticulated. The large specimen (pl. 15, fig. 41), shows somewhat coarser reticulations than common.

Young examples of this species are quite different in appearance from mature ones. Besides being more oblique, as is common in most young *Amphissites*, the nodes are much more prominent in the young of *A. pinguis*. In the smallest specimens, (pl. 15, figs. 21, 22) both nodes are prominent. With each subsequent molt the nodes become less well defined and the general surface more inflated, until in the most mature specimens no depression is apparent between the two nodes. Measurements of the three largest figured specimens and of the holotype as given by Ulrich and Bassler:

Figs.	12	13	14	holotype
Length	0.79 mm.	0.79 mm.	0.90 mm.	0.80 mm.
Height	0.52 mm.	0.44 mm.	0.48 mm.	0.48 mm.
Width				0.38 mm.

A. pinguis differs very little from

the Lower Pennsylvanian species *A. geneae* Roth[47] from the Francis and Holdenville formations of Oklahoma and the upper Fort Scott limestone of St. Louis County, Missouri. The species found at this latter locality was identified as *A. pinguis* by Knight[48] and subsequently referred by Warthin[49] to *A. geneae*. A study of Lower Pennsylvanian material shows that specimens of *A. geneae* are on the whole perhaps a little larger, Roth describing one from the Francis formation with a length of 1 mm., which is 0.1 mm. longer than any found in Kansas. The development of the slight outer flange at the ventral edge of the valve seems also to be greater on the whole in these early Pennsylvanian ancestors of *A. pinguis*.

A. minutus Roth[50] should be included in the synonomy of *A. geneae*. The type is a young specimen of the latter species, and a complete gradational series of forms between *A. minutus* and *A. geneae* has been found.

A recent examination of the type of *Cythere ? haworthi* Ulrich and Bassler by Dr. Bassler and myself shows it to be an early molt of *A. pinguis*, "the ventral wing-like process" being an adherent particle.

Immature specimens of *A. pinguis* resemble *A. koehleri* Delo[51] from the Wood Oil Company, Ranson well No. 1, Hamilton County, Kansas, but lack the posterior node and the ventral depression of *A. koehleri*.

A. pinguis is rare in the Upper Pennsylvanian of Kansas until in the uppermost part it becomes common and continues to be conspicuous through the lower part of the Permian, up to and including the Wreford formation. It was not found above the Wreford. Rare in the Stanton limestone, Middle Pennsylvanian, at Loc. 22, 1 specimen; 19 specimens present in the Dover (?) limestone, Loc. 40, of the Wabaunsee group, Upper Pennsylvanian. Common in the Permian. Americus limestone, Loc. 70, 3 specimens. Elmdale formation, Loc. 41a, 2 specimens; Loc. 60X, 3 specimens; Loc. 60, 1 specimen; and Loc. 64, 11 specimens. Neva limestone, Loc. 42, 3 specimens; Loc. 66, 2 specimens; Loc. 67, 20 specimens. Cottonwood limestone, Loc. 44, 37 specimens; and Loc. 73, 10 specimens. Garrison formation, Loc. 59, 1 specimen. Wreford formation, Loc. 43, 9 specimens; Loc. 57, 6 specimens; Loc. 68, 20 specimens. Plesiotypes, U. S. Nat. Mus. No. 85456, and No. 85457.

AMPHISSITES CENTRONOTUS (Ulrich and Bassler)

Plate 16, figures 16–22

Kirkbya centronota ULRICH AND BASSLER, *1906*, Proc. U. S. Nat. Mus., vol. 30, p. 159, pl. 11, figs. 16, 17; Cottonwood shales, 2 miles east of Cottonwood Falls, Kansas. *Amphissites centronota* (Ulrich and Bassler),

[47] Roth, Robert, *Pub. Wagner Free Inst. Science*, vol. 1, 1929, p. 42, pl. 2, fig. 12; *Jour. Pal.*, vol. 3, 1929, p. 292.

[48] Knight, J. Brookes, *Jour. Pal.*, vol. 2, 1928, p. 263, pl. 32, fig. 9; pl. 34, fig. 3.

[49] Warthin, Aldred A., *Okla. Geol. Sur.*, Bull. 53, 1930, p. 64, pl. 5, fig. 2.

[50] Roth, Robert A., *Publ. Wagner Free Inst. Science*, vol. 1, 1929, p. 44, pl. 2, figs. 13*a–c; Jour. Pal.*, vol. 3, 1929, p. 292.

[51] Delo, David M., *Washington Univ. Studies—n. ser., Science and Techn.*—no. 5 p. 45, pl. 4, figs. 6*a–c*.

HARLTON, *1927*, Jour. Pal., vol. 1, no. 3, p. 207, pl. 32, figs. 10*a*, *b*; Hoxbar formation, Carter County, Oklahoma.

Amphissites centronotus (Ulrich and Bassler), KNIGHT, *1928*, Jour. Pal., vol. 2, no. 3, p. 259–60, pl. 32, figs. 6*a–e*; pl. 34, fig. 2, upper Fort Scott limestone, St. Louis, Missouri. ROTH, *1929*, Wagner Free Inst. Science, vol. 1, pp. 9, 10, 48, 54. DELO, *1930*, Jour. Pal., vol. 4, no. 2, p. 160, pl. 12, fig. 9. Upper Carboniferous of a deep well in Schleicher County, Texas. WARTHIN, *1930*, Okla. Geol. Survey, Bull. 53, p. 66, pl. 5, figs. 4*a–c*; Wetumka to Holdenville formation, Oklahoma.

I can add nothing to the descriptions given by my predecessors of this well known and long-ranging species except to point out that the young, in common with the young of most species of *Amphissites* and of closely related genera, are more attenuated anteriorly in the side view than are mature specimens. Note the difference in outline shown in Plate 16 between the two smallest specimens, figs. 21, 22, and the larger specimens. Measurements largest specimens figured in this paper and of the holotype given by Ulrich and Bassler:

Fig.	16	17	Holotype
Length	0.73 mm.	0.76 mm.	0.82 mm.
Height	0.43 mm.	0.43 mm.	0.50 mm.
Width			0.50 mm.

Present in the majority of localities of the Pennsylvanian and Permian, beginning with the lowermost localities which are in the Middle Pennsyl-

EXPLANATION OF PLATE 16

All figures ×30

FIGS. 1–7—*Knightina harltoni* Kellett, n. sp. Ontogenetic series from the Stanton (?) limestone, Loc. 21B. Holotype, U. S. Nat. Mus. No. 85458; paratypes, U. S. Nat. Mus. No. 85458a–e. 1, Right valve, paratype. 2, Dorsal view, holotype. 3, Right side carapace, holotype. 4, Right valve. 5, Right side carapace, titled up ventrally showing dark muscle spot. 6, 7, Left side carapaces, very young specimens.

8–15—*Knightina minuta* (Harris and Lalicker). Ontogenetic series from the Fort Riley limestone, Loc. 45. Cyrioplesiotype, Figs. 8, 9, U. S. Nat. Mus. No. 85459; plesiotypes, U. S. Nat. Mus. No. 85459a-f. Left valves, 10–12; right valves, 13–15. 8 is a dorsal view of 9, the anterior end being to the left. Note the greater anteroventral obliquity of the smaller specimens, a characteristic of the Kirkbyidae.

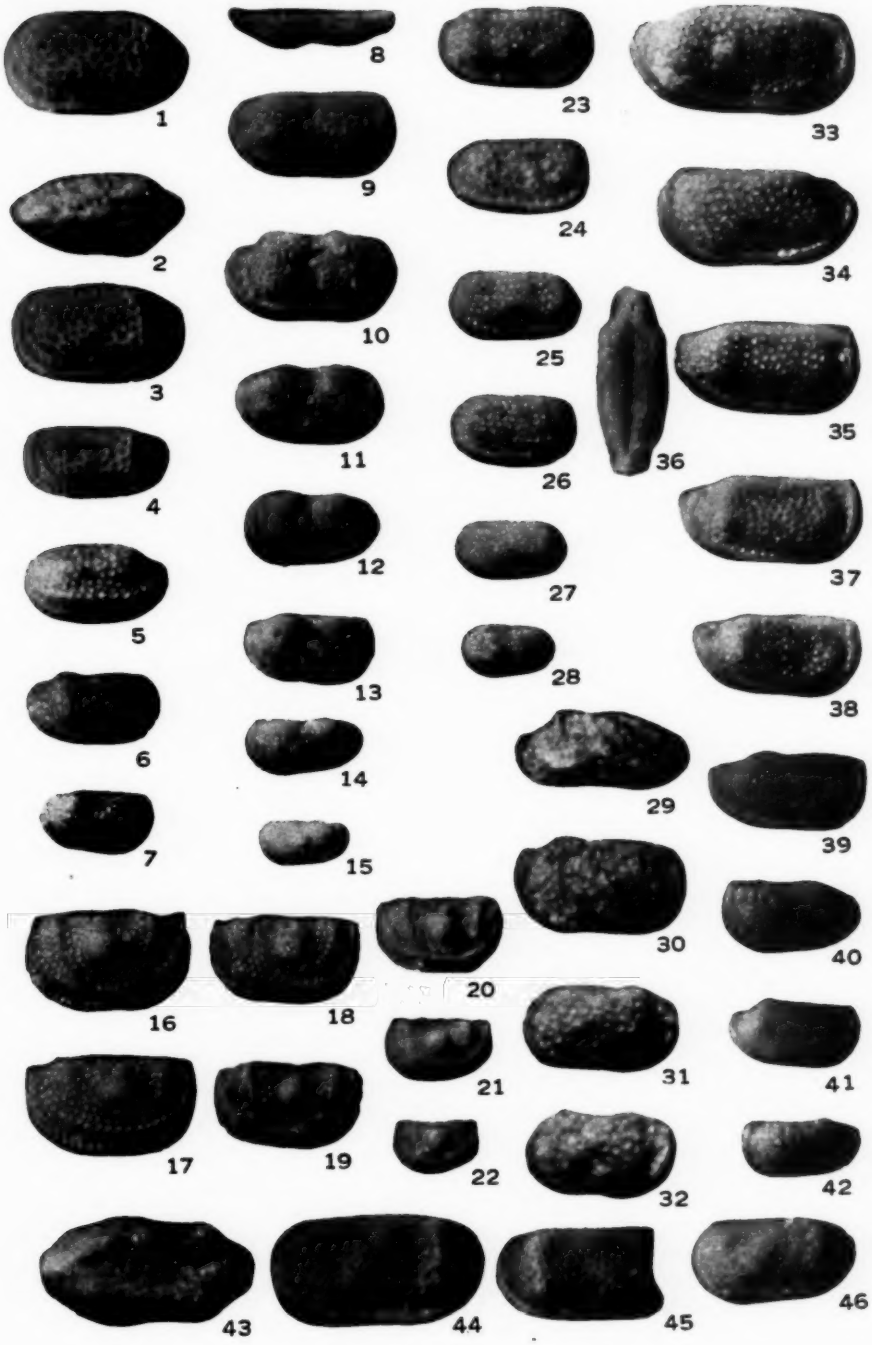
16–22—*Amphissites centronotus* (Ulrich and Bassler). Ontogenetic series, Wreford formation, Loc. 43B, plesiotypes, U. S. Nat. Mus. No. 85454. Left valves, 17, 20; right valves, 16, 21 and 22. Note the elongation of 17 as compared with 16.

23–28—*Knightina texana* (Harlton). Ontogenetic series from the Cottonwood limestone, Loc. 44, plesiotypes, U. S. Nat. Mus. No. 85460. Cyrioplesiotype, 23; left valves 23, 24 and 26; right valves, 25, 27 and 28. Note the greater anteroventral obliquity of the smaller specimens.

29–32—*Knightina incurva* Kellett, n. sp. Winfield formation, Loc. 56. Holotype, U. S. Nat. Mus. No. 85462; paratypes, U. S. Nat. Mus. No. 85462a, b. 29, Ventral aspect of 30, anterior to the left. Note the decided upward curve of the inner flange at the venter. 30, Left valve, paratype. 31, Right valve, holotype. 32, Right valve, paratype.

33–42—*Knightina bassleri* Kellett, n. sp. Ontogenetic series from the Wreford formation, Loc. 57; holotype, U. S. Nat. Mus. No. 85461; paratypes, U. S. Nat. Mus. No. 85461a–h. Note the increasingly larger reticulation meshes of the larger valves. 33, Left valve. 34, Right valve. 35, Holotype, left side carapace. 36, Holotype, dorsal view, anterior at the top. 37–39, Left valves, 40, Right valve. 41, Left side carapace. 42, Right side carapace.

43–46—*Knightina ampla* Kellett, n. sp. Deer Creek formation, Loc. 1. Holotype, U. S. Nat. Mus. No. 85463; paratypes, U. S. Nat. Mus. No. 85463a–b. 43, Holotype, dorsal view, right end the anterior. 44, Right side holotype. 45, Left valve, posterior broken. 46, Right valve.



Kellett, Pennsylvanian and Permian ostracodes

vanian and continuing up to the Wreford formation. *A. centronotus* was not found in the Fort Riley limestone but a few specimens occurred above in the Winfield formation at Loc. 75. Found in the greatest numbers at Loc. 15, Wakarusa limestone, Shawnee group, Pennsylvanian, 38 specimens; at Loc. 64, Elmdale formation, Permian, 30 specimens; and at Loc. 68, Wreford formation, Permian, 39 specimens. Plesiotypes, U. S. Nat. Mus. No. 85454.

AMPHISSITES (?) SIMPLICISSIMUS Knight
Plate 15, figure 18

Amphissites simplicissimus KNIGHT, *1928*, Jour. Pal., vol. 2, p. 266, pl. 32, fig. 11, pl. 34, fig. 6; upper Fort Scott limestone, St. Louis County, Missouri. HARLTON, *1929*, Univ. Texas Bull. 2901, p. 151, pl. 1, figs. 13*a–c;* Canyon group, Menard County, Texas. WARTHIN, *1930*, Okla. Geol. Survey, Bull. 53, p. 67, pl. 5, figs. 1*a–b*; Wetumka to Holdenville formations. DELO, *1930*, Jour. Pal., vol. 4, No. 2, p. 158, pl. 12, figs. 8*a–b;* Carboniferous of a deep well, Menard County, Texas.

Carapace sub-oblong in side view with rounded ends of about equal height. Sides parallel in dorsal view. Hinge-line almost as long as the carapace. Cardinal angles of the left valve on very large specimens slightly elevated, hinge-line depressed along its entire width; on the largest specimen the cardinal depressed area can be seen to be a little wider in the anterior half. No cardinal teeth and sockets could be found. Left valve the larger, overlapping the right slightly except at the hinge. Surface almost flat and reticulated. Pit smooth, circular, not depressed or rimmed; and about the size of four reticulation pits. Spinelets at the corners of the reticulation meshes not abundant. Faint transverse striations along the free edges are the only indications of the flanges, except a definite raised line found on the largest specimens almost at the extreme edge of the venter of the left valve.

Measurements of the cyrioplesiotype: length, 0.68 mm.; height, 0.39 mm.; only a few hundredths of a mm. smaller than the type. Measurements of the largest specimen from the Wreford formation at locality 43: length, 0.85 mm.; height, 0.46 mm.

It might be noted that *A.* (?) *simplicissimus* bears a resemblance to *Cytherella* (?) *reticulosa* Jones and Kirkby,[52] but the latter is more oblique posteriorly in side view, and also thicker at the anterior.

Found only in the Permian. Elmdale formation, Loc. 41a, 1 specimen; Loc. 63, 2 specimens; Loc. 64, 16 specimens; Loc. 65, 1 specimen. Wreford formation, Loc. 43, 13 specimens; Loc. 68, 20 specimens. Winfield formation, Loc. 56, 29 specimens; Loc. 75, 3 specimens. Plesiotype, U. S. Nat. Mus. No. 85455.

Genus KNIGHTINA Kellett n. gen.

Amphissites, part, of authors.

Small, elongate, sub-clavate Kirkbyidae with obtuse cardinal angles, the ends rounded, the anterior the more acutely rounded and rather narrow. Free margin of the left valve rabbetted to take the edge of the right, thus slightly overlapping it.

[52] Jones and Kirkby, *Annals Mag. Nat. Hist.*, (3), vol. 18, 1886, pp. 249–69, pl. 8, figs. 22–23

Cardinal teeth and sockets poorly developed if present in this genus. An outer flange extends along the free edge with an inner flange just inside and usually directly above it, so that when viewed from the side only this one flange is apparent and it appears to border the valve. Both flanges are narrow. The prominent anterior shoulder, typically non-carinate, rises near the hinge-line and passes downward almost to the inner flange; it has an abrupt anterior face but posteriorly there is only a slight depression or a gentle slope. The surface of the valve in front of this anterior shoulder or node is flattened or gently sloping. Except for this one prominent shoulder the valve shows only very gentle convolutions, the central node being represented by a faint ridge trending obliquely toward the anterior cardinal angle. The muscle spot which is usually rounded or nearly circular, is located in front of this ridge at about mid-length and below the mid-height of the valve.

Genotype, *Knightina allorismoides* (Knight), (*Amphissites allorismoides* Knight).[53] Upper Fort Scott limestone, Marmaton, lower Pennsylvanian, St. Louis County, Missouri.

The prominent anterior shoulder of *Knightina* occurring on a valve with no other outstanding surface feature is analogous to the shoulder of many Kirkbyas such as *K. clarocarinata* Knight and *K. punctata* Kellett, but the rounded cardinal angles of *Knightina* differentiate it conspicuously from these species of *Kirkbya*. *Knightina* is differentiated from *Amphissites* by its more elongate form and by the prominent anterior shoulder combined with the obscure configuration of the remainder of the valve. The only species of *Amphissites* which resembles species of the genus *Knightina* enough for confusion is *A. roundyi* Knight, which is relatively short and which has an incomplete inner flange.

The following species are referred to *Knightina: Amphissites allorismoides* Knight, *A.* (?) *texanus* (Harlton),[54] *A.* (?) *hextensis*[55] Harlton, *A.* (?) *menardensis*[56] Harlton, *A. permianus* (Jones) Roth,[57] *Kirkbya perplexa* Roth,[58] and *Ulrichia minuta* Harris and Lalicker.[58a]

Amphissites permianus (Jones) Roth is a homonym of *Kirkbya permiana* Jones, generic and subgeneric names being coordinate from a nomenclatural standpoint, and it must be suppressed and a new name supplied for the species. Roth remarks of this latter species that the obtuse cardinal angles and the dentation seem to be characteristic of *Amphissites*, but that the general outline resembles *Kirkbya*. Four new species described in the following pages, making eleven species altogether, are placed in the genus *Knightina: K.*

[53] Knight, J. Brookes, *Jour. Pal.*, vol. 2, 1928, pp. 265, 266, pl. 32, figs. 10*a–c;* plate 34, fig. 4.

[54] Harlton, Bruce H., *Jour. Pal.*, vol. 2, 1928, p. 135, pl. 21, figs. 6*a, b.*

[55] Harlton, B. H., *Univ. Texas Bull.* 2901, Oct. 1929, p. 152, pl. 2, figs. 6*a–d.*

[56] *Ibid.*, p. 151, pl. 1, fig. 12.

[57] Roth, Robert, *Pub. Wagner Free Inst. Science*, vol. 1, 1929, pp. 4–5.

[58] *Ibid.*, p. 29, pl. 1, figs. 8*a–c.*

[58a] Harris, R. W. and Lalicker, Cecil G., *Am. Midl. Nat.*, vol. 13, 1932, p. 403, pl. 37, fig. 6.

harltoni, *K. ampla*, *K. bassleri*, and *K. incurva*.

No species of this genus has yet been described from the Mississippian, its first appearance so far as known being in the Cherokee series of the Pennsylvanian. *Knightina* predominates in number of species over *Amphissites* in the Permian of Kansas, four species of this genus occurring and only three species of *Amphissites*, all of which are long-ranging, having existed from the Marmaton to the Permian with little if any change.

The name is given in honor of Dr. J. Brookes Knight of Yale University who first suggested to the author that these closely related species be grouped into a new genus. This was also indicated by Mr. Bruce H. Harlton at a meeting of the Tulsa Stratigraphical Society in connection with three of his species which he doubtfully referred to the genus *Amphissites*.

KNIGHTINA HARLTONI Kellett, n. sp.
Plate 16, figures 1–7

Carapace rather short for the genus but more elongate than any *Amphissites;* in dorsal view it is quite broad, being thickest at the antero-dorsal shoulder and tapering slightly to the anterior node. Ends blunt in side view. Cardinal teeth not developed. Antero-dorsal shoulder prominent and angular, with a steep anterior slope, posterior slope very slight and continuing almost unbroken to the posterior flange. The young specimens show a steeper slope immediately behind the antero-dorsal node. Area in front of this node very restricted. Central node represented by a faint ridge trending diagonally toward the antero-cardinal angle. It is most prominent just behind and above the muscle spot. Outer flange a nonreticulate line set well back from the free edge, about the width of two reticulation pits ventrally. Almost immediately above it and separated by two rows of reticulation meshes in a fine unreticulated line which probably represents the inner flange. This line is flush with the surface below it and slightly raised above the area immediately inside it. Muscle spot a rather large circular non-reticulate area with no rim and not depressed. It is encircled by six to eight reticulation pits.

Measurements of specimen shown in Plate 16, fig. 1: length, 0.66 mm.; height, 0.46 mm.; thickness, 0.36 mm.

K. harltoni is very closely related to *K. ampla*, n. sp., differing only in the smaller size, the narrower posterior two-thirds of the carapace in dorsal view, and the less rugose surface of the sides. *K. harltoni* bears a close resemblance to *K. allorismoides* (Knight) but the anterior shoulder is more prominent and angular instead of rounded at the crest, the pit larger and surrounded by six or eight instead of only five or six reticulation meshes, the flanges are separated by two instead of three rows of reticulation meshes, and the flanges are less well defined.

K. harltoni is larger, thicker and shorter than *K. texana* (Harlton). It lacks the extended anterior portion

in front of the antero-dorsal node of *K. bassleri*, n. sp., the thickened flange of *K. hextensis* (Harlton), and the third flange of *K. menardensis* (Harlton).

Lansing, Middle Pennsylvanian, common in the Stanton (?) limestone, at Loc. 21B, 15 specimens; found also in the Stanton limestone at Loc. 22, 2 specimens. Holotype, U. S. Nat. Mus. No. 85458; paratypes, U. S. Nat. Mus. No. 85458 a–e.

The name is in honor of Mr. Bruce H. Harlton of the Amerada Petroleum Corporation, who has described many of the ostracodes of the Mid-Continent area.

KNIGHTINA AMPLA Kellett, n. sp.
Plate 16, figures 43–46

This species is very closely related to *K. harltoni*, differing in its larger size, thicker flanges and in the thicker posterior half which can be seen in dorsal view. The surface convolutions of *K. ampla* are much better defined, there being a constant depression between the distinct oblique central ridge and the antero-dorsal shoulder or ridge. The depression behind the transverse central ridge is almost completely rimmed on the larger specimen. These ridges and depressions, taken as a whole and including the antero-dorsal node, form an almost complete figure 8.

Measurements of the largest figured specimens: length, 0.94 mm.; height, 0.47 mm.; width, 0.47 mm.

Common in the Deer Creek formation, Shawnee group, Pennsylvanian at Loc. 1, 32 specimens. Holotype, U. S. Nat. Mus. No. 85463; paratypes, U. S. Nat. Mus. No. 85463 a–d.

KNIGHTINA TEXANA (Harlton)
Plate 16, figures 23–28

Kirkbya texana HARLTON, *1928*, Jour. Pal., vol. 2, p. 135, pl. 21, figs. 6*a*, *b*; Cisco group, Eastland County, Texas.
Amphissites (?) *texanus* (Harlton), *1929*, Univ. Texas Bull. 2901, p. 149, pl. 1, fig. 11. Canyon group, Menard County, Texas (?).

Very small and rather thin species of the genus *Knightina*. No hingement observed. Appearance in side view short with ends very blunt and only a slight obliquity of the ventral outline. The most prominent surface feature is the antero-dorsal shoulder which is low, and the indistinct central ridge, characteristic of the genus, running obliquely up toward the anterior cardinal angle. Behind this ridge there is a faint tendency towards a depression, the whole configuration (pl. 16, fig. 25) forming the "8" characteristic of the genus.

Outer flange a thin but distinct raised line about the distance of one row of reticulation meshes from the edge of the valve. Inner flange set above or slightly within the outer, smooth at the edge but with one row of reticulation pits extending along the inner side (pl. 16, fig. 23). The area between the flanges is narrow, about the width of one row of reticulation meshes, and is covered by two rows of one-half reticulation meshes. The pit which is a circular depression, and larger than a reticulation mesh, can be seen in Plate 16, fig. 24. Measurements of the cyrioplesiotype (pl. 16, fig. 23): length, 0.68 mm.; height, 0.32 mm.

K. texana is smaller and flatter than the other species of *Knightina* figured here. It often occurs in great abundance along with *K. bassleri*, n. sp., but with a little care it can be separated from the young of *K. bassleri*, which latter are narrower and more pointed anteriorly with a considerable flattened area in front of the antero-dorsal shoulder. *K. texana* is not the same species as *K. allorismoides* (Knight), which latter species is more rounded at the postero-dorsal angle, less blunt anteriorly, and has three rows of reticulation pits between the flanges.

The young of *K. texana* show the narrower anterior characteristic of the young of the Kirkbyidae.

Permian. Rare in the Elmdale formation (?) at Locs. 41, 3 specimens, 41a, 1 specimen. Common in the Cottonwood limestone at Locs. 44, 50 specimens; and 73, 6 specimens. Common in the Wreford formation at Locs. 68, 14 specimens; 43, 60 specimens; and 47, 33 specimens. Fort Riley limestone, common at Loc. 45, 75 specimens; and rare at Loc. 77, 1 specimen. Common in the Winfield formation at Loc. 75, 15 specimens. Plesiotypes, U. S. Nat. Mus. No. 85460.

KNIGHTINA BASSLERI Kellett, n. sp.
Plate 16, figures 33–42

Carapace very elongate and rather thin. In side view the anterior end is narrowly rounded and the antero-ventral outline very oblique for the genus, with the widest part of the valve at the post-dorsal angle. Antero-dorsal shoulder quite distinct and very steep anteriorly with a wide flat area in front of it. Central oblique ridge characteristic of the genus trending between the anterior cardinal and the post-ventral angle very indistinct, as are the accompanying depressions in front of and behind it. The two flanges are low, thickened and located very close to the edge; they are very close together, being separated by scarcely more than a wide groove even at the venter. This groove shows only a faint tendency toward reticulation. The inner flange is almost directly above the outer. Pit fairly large and oval but ill defined (pl. 16, figs. 35, 37). Reticulations prominent. The young of this species show the usual smaller reticulations, and also in side view the very oblique anterior outline. The largest specimen illustrated has a depression along the middle of the venter which is due to deformation. Measurements of two of the figured specimens: length (Fig. 33) 1.00 mm., (Fig. 35) 0.82 mm.; height (33) 0.47 mm., (35) 0.38 mm.; width (35) 0.30 mm.

K. bassleri is easily distinguished from all other members of the genus by its elongate form, tapering anteriorly in side view, and by the wide flattened antero-dorsal area.

Permian. Common in the Neva limestone at Loc. 67, 12 specimens. Common in the Garrison formation at Loc. 59, 8 specimens. In the Wreford formation abundant at Loc. 57, 47 specimens, and rare at Loc. 47, 1 specimen. Present in the Fort Riley limestone at Locs. 45, 14 specimens; and 77, 3 specimens. Not found in the Winfield formation. Holotype, U. S.

Nat. Mus. No. 85461; paratypes, U. S. Nat. Mus. No. 85461a–h.

The name is in honor of Dr. R. S. Bassler of the United States National Museum.

KNIGHTINA INCURVA Kellett, n. sp.
Plate 16, figures 29–32

Carapace short for the genus and of medium thickness. In side view the ends are very blunt and of equal height. The venter is indented centrally. Surface noding is distinct and entirely typical of the genus; a letter Z is formed by the anterior shoulder and a faint posterior ridge connected by the oblique central ridge crossing the valve between the post-ventral and the antero-cardinal angles. This surface contouring is not so well developed on the more inflated valve of the largest specimen figured. A slight angular carina is also developed along the crest of the antero-dorsal shoulder of this largest specimen, but it is not seen on the smaller specimens.

Flanges low and thick, very close to the free edges, and so close together as to be separated only by a groove, except at the middle of the venter. There for about a third of the length of the valve the inner flange swings inward and is separated from the outer by one row of reticulation meshes (pl. 16, fig. 29). The inner flange is almost directly above the outer. Reticulation meshes very large and irregular. Muscle spot obscure, small and not rimmed. Measurements of the specimen shown in Plate 16, figs. 29, 30: length, 0.76 mm.; height, 0.42 mm.

The outline of *K. incurva* is too short and blunt to be very typical of the genus *Knightina*, but the surface configuration seems to place it definitely in this genus. The incurving of the inner flange at the ventur distinguishes *K. iucurva* from *K. texana* (Harlton) and from all other similar species.

Permian. Present in the Wreford formation at Loc. 46, 3 specimens; rare in the Winfield formation at Loc. 75, 2 specimens; common in the Winfield formation at Loc. 56, 34 specimens. Holotype, U. S. Nat. Mus. No. 85462; paratypes, U. S. Nat. Mus. No. 85462 a, b.

KNIGHTINA MINUTA (Harris and Lalicker)
Plate 16, figures 8–15.

Ulrichia minuta HARRIS AND LALICKER, *1932*, Am. Midl. Nat., vol. 13, p. 403, pl. 37, fig. 6; Fort Riley limestone, Permian; Cowley County, Kansas.

Carapace thin and in side view fairly elongate and tapering with well rounded ventral corners. The largest specimens show a slight, ventral marginal indentation. Antero-dorsal shoulder well developed and extending above the hinge-line, very steeply sloping at the anterior, at the posterior sloping more gently to the central vertical depression or sulcus. This narrow sulcus does not extend quite down to the inner flange. The posterior surface is evenly rounded except for the abrupt shoulder immediately behind the vertical sulcus at the hinge. From the center of the vertical sulcus, extending toward the posterior is a short, scarcely noticeable, horizontal depression. The outer flange is a well defined ridge, and the

inner, though thin, is more prominent, being elevated well above the surface. The outer flange is ventrally well separated from both the free edge and from the inner flange, with the area between the two flanges obscurely reticulate. Ventrally the valve slopes so that both flanges are visible in side view. Surface reticulations small. Pit obscure; a small rounded depression at the ventral end of the sulcus. Young specimens show the greater obliquity of young Kirkbyidae. The dorsal shoulder just behind the sulcus is obsolete on the smallest specimens, and the sulcus is shortened so that it scarcely extends down to the mid-height of the valve. Measurements of the specimen shown Plate 16, fig. 9: length, 0.74 mm.; height, 0.36 mm.

The binodate character of *K. minuta* gives it somewhat the appearance of an *Ulrichia*, but the nodes are much lower and broader and the outline in side view is entirely different. This outline is quite typical of the genus *Knightina*, and it is because of it and of the anterior shoulder that the species is referred to that genus. No other *Knightina* shows the prominent central sulcus.

Pennsylvanian and Permian. Rare in the Stanton limestone at Loc. 22, 1 specimen; and the Deer Creek formation at Loc. 1, 2 specimens. Rare in the Burlingame formation of the Wabaunsee group at Loc. 71, 1 specimen. Present in the Falls City (?) limestone, Permian at Loc. 40, 2 specimens; Garrison formation, Permian, at Loc. 58, 2 specimens; Wreford formation, Permian, at Loc. 43, 2 specimens; common in the Fort Riley limestone, Permian, at Loc. 45, 74 specimens; and rare in the Winfield formation at Loc. 56, 1 specimen. Cyrioplesiotype, U. S. Nat. Mus. No. 84559; plesiotypes, U. S. Nat. Mus. No. 85459 a-f.

Family YOUNGIELLIDAE Kellett, new family

Youngiella JONES AND KIRKBY, *1895*. *Youngia* JONES AND KIRKBY, *1886*, Proc. Geol. Assoc., vol. 11, p. 515, text figs. 5–7 (preoccupied). *Youngiella* JONES AND KIRKBY, *1895*, Ann. Mag. Nat. Hist., 6 ser., vol. 16, pl. 21, figs. 5*a–d*. ULRICH AND BASSLER, *1923*, Maryland Geol. Survey, Silurian, p. 315, text fig. 22 (1, 2) (reproductions of the original figure).

Moorites CORYELL AND BILLINGS, *1932*, Am. Midland Naturalist, vol. 13, no. 4, pp. 182–183, pl. 18, figs. 5–7.

The family Youngiellidae is proposed to include the closely related genera *Youngiella* Jones and Kirkby and *Moorites* Coryell and Billings which were formerly placed in the family Kirkbyidae. *Youngiella* and *Moorites* do not possess the hinge and marginal structure, kirkbyan pit, homologous nodes and typical reticulation of the genus *Kirkbya* and its several very closely related genera and therefore should not remain in the family Kirkbyadae. The close relationship of the genera *Youngiella* and *Moorites* was discovered by Dr. J. Brookes Knight and Dr. Charles W. Wilson. The evidence of this close relationship will be presented in a forth-coming paper by Dr. Wilson.

The genus *Moorea*[59] Jones and

[59] Jones, T. R., and Kirkby, J. W., *Quar. Jour. Geol. Soc. London*, vol. 23, 1867, p. 494.

Kirkby, 1867, should certainly be removed from the Kirkbyidae. The elevated marginal ridges of the genotype *Moorea obesa* Jones and Kirkby[60] might indicate a relationship to *Moorites*, but the lateral outline is totally different from either *Youngiella* or *Moorites*. At present nothing is known of the hinge structure.

Genus MOORITES Coryell and Billings, 1932

Moorites CORYELL AND BILLINGS *1932*, Am. Midland Naturalist, vol. 13, no. 4, pp. 182–183, pl. 18, figs. 5–7.

Carapace minute and thin, laterally subrectangular, hinge-line straight. Free edges of valves meeting evenly with no apparent overlap. Surface (in adults at least) ornamented by a slightly elevated marginal border and by a low, elongate, looplike, costa, indistinct and branching in the post-dorsal area. Surface finely pitted except on the marginal border and costa.

Genotype by original designation *Moorites hewetti* Coryell and Billings which is a synonym of *Moorites minutus* (Warthin).

Range, Lower to Upper Pennsylvanian.

MOORITES MINUTUS (Warthin)

Plate 14, figures 37–39

Glyptopleurina (?) *minuta* WARTHIN, *1930*, Okla. Geol. Survey, Bull. 53, p. 67, pl. 5, figs. 6*a–b*. Sasakwa limestone member of the Holdenville formation, Oklahoma.

Moorites minutus (Warthin), CORYELL AND BILLINGS, *1932*, Am. Midland Naturalist, vol. 13, no. 4, p. 183, pl. 18, fig. 6. Graham formation, Wayland shale; Eastland County, Texas.

Moorites hewetti CORYELL AND BILLINGS, *Ibid.*, p. 182, pl. 18, fig. 5, Graham formation, Wayland shale; Eastland County, Texas.

Moorites truncatus CORYELL AND BILLINGS, *Ibid.*, p. 183, pl. 18, fig. 7. Graham formation, Wayland shale; Eastland County, Texas.

Carapace minute and thin; dorsally the ends appear truncated and almost as thick as the central portion of the valve; laterally carapace subrectangular, slightly elongate with little backward swing, cardinal angles obtuse, hinge-line long and straight, ends well rounded and venter broadly concave, valve highest in the post-ventral portion and lowest just in front of the center. Hinge-line slightly impressed in the anterior half. Free edges of valves meeting evenly with no apparent overlap. A wide, conspicuous, smooth, slightly elevated marginal border extends around the valve except at the hinge. Surface ornamented by a low, elongate, looplike, irregular costa, indistinct and branching in the post-dorsal area. Surface pitted except on the marginal border and the costa. Complete carapaces usually found. Measurements of the cyrioplesiotype: length, 0.46 mm.; height, 0.25 mm.; width, 0.18 mm.

M. hewetti is placed in the synonymy of *M. minutus* because their only differentiating character, the dissimilarity in the anterior convergence of the ventral and dorsal margins, is believed to be a very common variation within a species. Earlier molts in the Kirkbyidae are almost always more narrow anteriorly in lateral

[60] Jones and Kirkby, *Ibid.*, pp. 525, and 559. Jones and Kirkby, *Ann. Mag. Nat. Hist.*, 5th ser., vol. 18, 1886, p. 261, pl. 8, figs. 20*a, b*. Ulrich and Bassler, *Maryland Geol. Survey*, Silurian, 1923, p. 315, text fig. 22 (3) (reproduction of the original figure.)

view than the adult molts, a decided tendency also noted in genera of other families. The same variations in the anterior convergence are found in the specimens of *Moorites* from Kansas, the figured specimen being in this character about half way between the figured specimens from Texas. *M. truncatus* is included also in the synonomy of *M. minutus;* the higher carapace of *M. truncatus* is a common form of individual variation within a species, being found in species with such distinctive ornamentation as *Amphissites centronotus* (pls. 15, 16). The specimens of *M. minutus* found in Kansas exhibit a great variation in the ratio of length to height. The ornamentation of the form figured as *M. truncatus* is believed to be less distinct than that of *M. minutus* because it is a much smaller and therefore very probably an earlier molt, a common variation in the young of *M. minutus* of many localities.

Youngiella (?) *elongata* (Jones and Kirkby) (=*Cytherella* (?) *elongata* Jones and Kirkby),[61] from the Carboniferous of Scotland has a similar outline and a marginal border, but lacks the ornamented surface of *M. minutus*.

Pennsylvanian. Stanton (?) limestone, Loc. 21b, 3 specimens; Deer Creek formation, Loc. 18, 13 specimens, and Howard formation, Loc. 25, 4 specimens.

Cyrioplesiotype, U. S. Nat. Mus. No. 85447.

[61] Jones, T. R., and Kirkby, J. W., *Ann. Mag. Nat., Hist.*, (5), vol. 18, 1886, pp. 249–69, pl. 9, figs. 2, 3.

REGISTER OF KANSAS FOSSILS

LOCALITIES

1. Lower (?) Deer Creek formation, Shawnee group, Pennsylvanian; decomposed limestone from outcrop on Highway 73W, ¼ mile west of Oskaloosa, Jefferson County, Kansas.
12. Stanton limestone, Middle Pennsylvanian; shale partings in small quarry in pasture near bridge on Route 10, ¼ mile east of Eudora, Douglas County, Kansas.
13. Stanton limestone, shale partings in upper part, on Route 10, 1 mile east of Loc. 12, on north bank of creek.
15. Wakarusa (?) limestone, Wabaunsee group, Upper Pennsylvanian; SE corner sec. 3, T. 13S, R. 15E, about 6 miles S by SW of Topeka, Shawnee County, Kansas. This outcrop is on a road near a small church. (In a preceding publication this limestone was called the Burlingame.)
16. Burlingame limestone, Wabaunsee group, Upper Pennsylvanian; SE corner sec. 34, T. 12S, R. 15E, 5 miles S by SW of Topeka, Shawnee County. This outcrop is on the Burlingame-Auburn road which continues out from Lincoln Street, Topeka.
17. Top of Ervine Creek limestone member, Deer Creek formation of the Shawnee group, Pennsylvanian; railroad cut by Kansas River just west of the Shawnee-Douglas County line crossing Highway 10.
18. Samples taken from the shaly beds just above those in Loc. 17.
21. Stanton (?) limestone, Middle Pennsylvanian; shale partings in massive limestone outcropping at lower part of hill on Highway 32, above Kansas River and Union Pacific Railroad, ¼ mile west of Linwood, Leavenworth County, Kansas.

21A. Stanton (?) limestone, weathered limestone and soil collected just north of the highway at Loc. 21 in the pasture.

21B. Stanton limestone, Middle Pennsylvanian, sample collected from partings in thinly bedded but very thick limestone at the top of the hill described under Loc. 21.

21C. Shale at the base of the limestone described as Loc. 21B.

22. Stanton limestone, cut on Highway 40, just west of Victory Junction, Leavenworth County, between Lawrence and Kansas City, Kansas.

22B. Stanton limestone, quarry across the road from Loc. 22.

23. Stanton limestone, U. S. Highway 73E, 2 miles south of Lansing by Nine Mile School, District No. 17, Leavenworth County, Kansas.

24. Oread or Iatan limestone, Middle Pennsylvanian. Gray limestone in road cut about 600 feet south of the Missouri River bridge at the Fort Leavenworth Military Reservation, Leavenworth County, Kansas.

24A. Oread or Iatan limestone at the west end of the Missouri River bridge at the Reservation.

25. Howard formation, Wabaunsee group, Upper Pennsylvanian; brick plant cut in field, north of Gage Park, Topeka, Shawnee County, Kansas.

26. Topeka formation, Shawnee group, Pennsylvanian; from road cut where East 17 Street, Topeka, becomes Hudson Boulevard, as road curves and turns up the hill after crossing a bridge.

27. Topeka formation, partings in limestone on north side of road in ditch, S line sec. 10, T. 12S, R. 16E, about ¼ mile west of District No. 38 School, which is at the SE corner of the section on Watson Road, south end of Topeka.

28. Topeka formation, road cut C S line sec. 10, T. 12S, R. 16E, very small quarry just behind outcrop.

30. Limestone in Scranton formation, Wabaunsee group; a blue, micaceous, slightly fossiliferous limestone a few inches thick, included in a 4 foot outcrop of calcareous platy shale; exposed in a pasture gully along the center of the S line of sec. 17, T. 13S, R. 15E, on the Burlingame-Auburn road, 2¼ miles east of the NE corner of Auburn, Shawnee County, Kansas.

32. Tarkio limestone, Wabaunsee group, outcrop on main road straight north from Auburn, limestone characterized by an abundance of very large Fusulinidae, Shawnee County, Kansas.

34. Topeka formation, Shawnee group; abandoned quarry in SW¼ of sec. 7, T. 12S, R. 16E, on Shriner road just east of Highway 73, south of Topeka, Kansas.

40. Falls City limestone (?), upper Wabaunsee group; a rather massive, gray limestone, 3 feet thick, and containing many pelecypods; road cut at foot of hill in Wabaunsee County, about 1 mile south of Wamego, Kansas, but across the Kansas River on Kansas State Highway 29. This limestone is the first prominent one outcropping along the road west of the German Lutheran Church.

41. Elmdale (?) formation, Permian; second limestone from top of very high hill just southeast of Manhattan, Riley County, on Kansas State Highway 29.

41A. Elmdale (?) formation, weathered limestone in road cut at foot of hill below locality 41.

42. Neva limestone, Lower Permian; south of the Kansas State Agricultural College and near cemetery, Manhattan, Riley County, Kansas.

43. Wreford formation, Chase group, Permian; outcrops on hill along Highway 40 opposite the soldiers' monument, Camp Funston, Geary County, Kansas.

44. Cottonwood formation, Council Grove group, Permian, limestone on Highway 40 at Ogden, Riley County, Kansas.

45. Fort Riley limestone, Chase group; Permian, on Highway 40 opposite cemetery, Fort Riley, Geary County.

46. Wreford formation, Chase group, Permian; flinty limestone on hillside on the northwest of Highway 40. This locality is southwest of Junction City and immediately southwest of the juncture of Highways 40 and 77, Geary County, Kansas.

47. Wreford formation, small quarry in road cut of Highway 40, about 4 miles west of Junction City. This quarry is at the north side of the road.

52. Shale above a fossiliferous limestone, which is weathered light gray and is broken off in large blocks, probably Herington limestone, Permian. This limestone outcrops along a stream just north of the Union Pacific Depot in the eastern part of Herington, Dickinson County, Kansas. Microscopic fossils very rare.

56. Winfield formation, Chase group, Permian; outcrop at juncture on hillside of country road and highway, 8 miles southeast of Lincolnville, Marion County, on route to Elmdale. There are two limestones, separated by a yellow shale; the upper of the limestones is concretionary.

57 Wreford formation, low outcrop by north-south road, north of District No. 17 School, Chase County. This locality is between Lincolnville and Elmdale, and only a few miles from the latter. There are three limestones, the lower one being very cherty and overlain by yellow shale.

58. A limestone in the Garrison formation, road-cut on Highway 50S at west edge of Cottonwood Falls, Chase County, not far from the school.

59. A limestone, probably in the Garrison formation, cut which is on one side only of Highway 50S, about ½ mile west of Cottonwood Falls. There is about six feet of gray shale exposed below the limestone.

60–67. Elmdale formation with several included limestones and the Neva formation, all lower Permian as revised by Moore. This is a thick section exposed near the Cottonwood River bridge east of Elmdale, Chase County, Kansas, where the road winds up the hill.

60. Massive limestone about 8 feet thick in the Elmdale formation, exposed below the road and up-stream near the bridge. There is a thin shale parting about the middle, below which *fusulinids* are abundant. Ostracodes collected from this shale parting and from the shale on top of the limestone are beautifully preserved, many showing the muscle spots on the interior of the valves.

60X. This includes several collections from the limestones and shales of the lower Elmdale formation, collected a little farther upstream than locality 60, at the place where there is a prominent Fusulina-limestone at the water level. The several collections of 60X were made in the limestones and shales above the water level and below the road. Localities 60 and 60X are in part equivalent horizons.

62. Shale just below the massive buff limestone and above a thin cherty one in the cut where the road bends about half way up the hill. This is the first massive limestone below the Neva limestone.

63. Only shale parting in the massive buff limestone of locality 62, about six inches from the base of the limestone.

64. Very carbonaceous fossiliferous shale on top of the massive buff limestone of locality 62.

65. A lighter colored shale continuing above the carbonaceous shale of locality 64.

66. Neva formation, shale beneath a buff limestone full of *fusulinids*, which is several hundred yards up the road from locality 65.

67. Shale above the fusulinid limestone of locality 66.

68. Wreford formation, about 2½ miles west of Cottonwood Falls, Chase County, Kansas, on U. S. Highway 50S. Shale parts two limestones, the lower of which contains layers of chert.

69. Emporia formation, Wabaunsee group; at 18th Avenue and Merchant Street, Emporia, Lyon County, Kansas. A light gray limestone which weathers buff. Part of the sample was taken from a ditch being dug for a water main.

70. Americus limestone, base of Permian, 1¼ miles straight south of Allen, Lyon County, Kansas.

71. Burlingame formation, Wabaunsee group; on Highway 50N, 4 miles north of Burlingame, Osage County.

72. Howard formation, or possibly Topeka formation, limestone outcrop along road just east of Scranton, Osage County, Kansas. About five feet of shale is exposed below the limestone.

73. Shale immediately above the Cottonwood

limestone, Council Grove group, Permian; large abandoned quarry east of Cottonwood Falls, Chase County, Kansas.

75. Winfield formation, Chase group, Permian; SW¼ of sec. 20, T. 27S, R. 4E, about 17 miles east of Wichita, Kansas; road-cut on U. S. Highway 54.
77. Fort Riley limestone, Chase group, Permian; very large quarry 2½ miles south of Florence, Marion County, Kansas.

PALEONTOLOGICAL NOTES

TYPICAL FORM AND RANGE OF *MESOLOBUS MESOLOBUS*[1]

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In their original description of *Chonetes mesolobus*, Norwood and Pratten stated "Dorsal valve covered by extremely fine ribs. . . ." In 1915, when Girty described the varieties *Chonetes mesolobus decipiens* and *euampygus* he figured two striated specimens from Flint Ridge, Ohio, as representatives of the typical *Chonetes mesolobus*. All subsequent authors have considered *Chonetes mesolobus s. s.* to be a striated form.

Recent studies have shown that striated forms of *Chonetes mesolobus* consistently occur at lower horizons than the unstriated varieties *decipiens* and *euampygus*. In western Illinois striated specimens have been obtained only from the limestone of the Seville cyclothem. In Ohio they range as high as the Vanport limestone. Similar forms have been collected by one of us from horizons low in the Pennsylvanian system in Indiana, Iowa, Missouri, and Oklahoma.[2] We are informed by Mr. F. B. Plummer that striated specimens are characteristic of the beds below the Brazos conglomerate in Texas.

Unstriated specimens belonging to the *decipiens-euampygus* series are first common in the Liverpool cyclothem of Illinois and range upward into the Gimlet cyclothem. Specimens from the Washingtonville shale of Ohio seem to be referable to this series. In Iowa, Missouri, Kansas, and Oklahoma these forms are common and characteristic in the Marmaton group. According to Plummer they characterize the beds above the Brazos conglomerate in Texas.

It is obvious from the above outline of their stratigraphic distribution that these varieties of the old species *Chonetes mesolobus* are of considerable importance in the recognition of two distinct faunal zones in the Lower Pennsylvanian which may also be distinguished by other faunal differences. Unfortunately, in western Illinois only one of the half dozen or so cyclothems that intervene between the Seville and Liverpool cyclothems has yielded an important marine fauna and only a very few poorly preserved specimens of Dunbar and Condra's genus *Mesolobus* have been obtained from it. Therefore the upper limit of the zone characterized by the striated form and the lower boundary of the zone which bears the *decipiens-euampygus* series cannot be sharply determined in this region.

Norwood and Pratten's type specimens of *Chonetes mesolobus* have been lost. They stated: "This species occurs in the limestone and shales of the Coal Measures; at Bellville, Illinois; and at Charboniere, Missouri," and we must assume that the types were obtained from one of these localities. The lowest fossiliferous horizon that might formerly have been exposed near either of these places occurs in the Liverpool cyclothem but it cannot be seen at either of them today. Judging from an artificial exposure observed in the northern part of St. Louis, the Liverpool cyclothem in this region contains no limestone and the shales probably do not contain abundant or well preserved fossils. It seems likely that Norwood and Pratten's types, therefore, were obtained from the much more extensively exposed limestones and shales of the Summum, St. David, Brereton, or Sparland cyclothems higher in the section.

Because the marine horizons that elsewhere carry striated forms of *Mesolobus* are not present in the St. Louis district (they are unrepresented in the Chelten-

[1] Published by permission of the Chief, Illinois State Geological Survey.

[2] These collections were obtained through a Grant-in-Aid of the National Research Council to J. M. Weller in 1930.

ham fireclay) it is impossible that Norwood and Pratten's types could have been striated and their description is therefore erroneous.

Upon first consideration it would appear improbable that smooth shells should have been described by careful observers as striated. Recent studies of thousands of well preserved individuals, however, have shown that many of the best specimens, particularly those composed of translucent calcium carbonate, and also those which are slightly exfoliated, appear to be striated. This appearance is an illusion, however, as far as the unexfoliated specimens are concerned because when they are whitened with a thin film of sublimated ammonium chloride they are seen to be perfectly smooth except for fine concentric growth lines and minute pits marking the points of attachment of surface spines.

If these apparently striated specimens are examined under a low power binocular and the source of light is shifted slowly from one side to the other the striations seem to change their positions slightly. It is obvious, therefore, that the striated appearance of these shells is caused by differential refraction within the shell substance, or the formation of shadows, as it were, within the shell rather than upon its surface.

Dunbar and Condra have recently described the shell structure of the Chonetidae and pointed out that the supposed punctations result from the curving and thickening of the individual shell layers about radiating rows of papillae. This thickening of the shell layers, particularly near the exterior surface, along closely spaced radial lines is responsible for the differential refraction of light within the translucent shells and the production of their pseudostriated appearance. This structure also explains how originally smooth shells may be transformed into actually striated shells by exfoliation.

There can be no doubt that Norwood and Pratten's type specimens of *Chonetes mesolobus* belonged to the *decipiens-euampygus* series and it is proposed that the intermediate form designated by Dunbar and Condra as *Mesolobus mesolobus lioderma* be recognized as the type of this genus and species, to be known henceforth as *Mesolobus mesolobus s. s.* Because Norwood and Pratten's types have been lost and because the exact horizon and locality from which they were obtained is not known, it is suggested that certain specimens that have been selected by us from western Illinois be accepted as neotypes.

With the recognition of the typical form of *Mesolobus mesolobus*, the truly striated shells formerly considered to be typical of *Chonetes mesolobus* are left without a name. Because of their distinctive sculpture and restricted stratigraphic range these seem worthy of full specific standing. The name *Mesolobus striatus* is, therefore, proposed for them and a holotype, which will be described in a future publication, has been selected from the Seville limestone of western Illinois.

SOME TEXAS LOCALITIES OF *ORBITOLINA WALNUTENSIS* CARSEY

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There has been some discussion of the accuracy of the generic name of this fossil. Silvestri states in a footnote that *Orbitolina walnutensis* is a true *Dictyoconus*. (A. Silvestri, Pal. Italica, vol. 32 (n. ser., vol. 2), pt. 3—Fossili del Cretaceo della Somalia, p. 159, footnote 1, 1932.) This form will also be discussed in the immediate future in a paper by Vaughn.

A few principal localities in which *Orbitolina walnutensis* Carsey has been found include:

Tarrant County. a. 5800 West Byers Ave., Fort Worth. 30 ft. below the top of the Goodland.

b. Texas and Pacific Railroad cut, 1¾ miles west of shops, Fort Worth. Upper 20 ft. of Goodland.

c. "Cragin Knobs," 3½ miles west of Fort Worth, on Stove Foundry road. In a zone extending from 35 ft. to within 15 ft. of top of Goodland.

d. East end dam, Lake Worth. Upper 6 ft. of Goodland.

McLennan County. a. Bluff Creek, 3½ miles west of Crawford, in upper Comanche Peak.

b. Extreme northwestern part of county, along Middle Bosque River, in an 85 ft. vertical section of Fredericksburg. Occurrence throughout the Comanche Peak as exposed, a range of over 50 ft.

Bosque County. a. 3½ miles west of Walnut Springs on Glen Rose road, in upper Comanche Peak and lower Edwards.

Hood County. a. "Comanche Peak," 7 miles southwest of Granbury. Type locality of Comanche Peak as described by Hill. Occurrence in upper Comanche Peak and lower Edwards.

Bell County. a. On north and south section line road, four miles west of Belton on the Nolanville road, in middle and upper Comanche Peak and lower Edwards.

b. One mile west of Belton on the Nolanville road, in upper Comanche Peak and lower Edwards.

c. Santa Fe quarry, 3 miles northwest of Belton. This facies of the Edwards is described by Adkins in his bulletin on Bell County. *Orbitolina walnutensis* was found in all local phases.

Bosque-Hill Counties. a. West Bank of Brazos River, near bridge, on Hillsboro-Meridan road, in upper ledges of the outcrop, Goodland.

A study of samples from these areas lead to the following

Conclusions

a. Within the area, studied from the outcrops, the species *Orbitolina walnutensis* Carsey is limited to the Fredericksburg division of the Comanchean. In the southern part of the area it is in the lower Edwards, in the Comanche Peak and in the so-called Walnut formation. In the northern part of the area it is found in the middle and upper Goodland. Many suites of samples from various complete sections of upper Glen Rose, *Gryphea marcoui* conglomerate of the Walnut, upper Edwards, and Kiamitia have failed to furnish any fragment of this species.

b. The fossil is widely distributed horizontally and has been reported from the Balcones zone, West Texas, and in wells on the Sabine Uplift and along the Mexia-Powell fault area.

c. It occurs only in limestones and chalky clays, reaching a maximum size in a soft limestone. The marl and clays between two fossiliferous limestones are usually barren near the Fort Worth area but contain excellent specimens around Austin.

d. Since *Orbitolina walnutensis* Carsey is easily recognized, and is small enough to be preserved by drilling, and since it occurs over a wide spread area with rather limited vertical range, it possesses the qualities of an index fossil for subsurface work.

MICROCHEILINELLA, A NEW NAME FOR THE OSTRACODE GENUS *MICROCHEILUS*

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It has been recently ascertained that the ostracode genus *Microcheilus* Geis[1] is a homonymn of the gastropod genus *Microcheilus* Kittl.[2] The writer accordingly suggests that the name *Microcheilinella* be substituted for the ostracode genus. Due credit should be given J. B. Knight and J. M. Weller for bringing the error to the writer's attention.

[1] Geis, H. L., Some Ostracodes from the Salem Limestone, Mississippian, of Indiana: Jour. Pal., vol. 6, no. 2, p. 181, 1932.

[2] Kittl, E., Ann. Hofmus., Wein, v. 8, fasc. 2, p. 212, 1894.

CYTHERIDEA BRIGHTSEATENSIS BERRY, A NEW NAME FOR *C. TRUNCATA* BERRY

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In 1925 I described an ostracode from the Upper Cretaceous (Manmouth formation) as exposed at Brightseat, Prince George's County, Maryland as *Cytheridae truncata* (Am. Jour. Sci., ser. 5, vol. 9, p. 485. fig. 6, 1925.). In 1929 C. I. Alexander found similar ostracodes in the Cretaceous (Novarro formation) of North Texas which he identified as my species (Univ. Texas Bull. 2907, p. 75, pl. V, fig. 16, 1929).

Dr. J. B. Reeside, jr. has called my attention to the fact that this specific name is invalid as it was used by Jones for a species of the same genus in 1893 (Geol. Mag., n.s., Dec. 3, vol. 10, p. 390, 1893). To correct the record I propose that the form described by myself as *C. truncata* and so used by Alexander be called *C. brightseatensis* new name W. Berry.

REVIEWS AND NEW PUBLICATIONS

CHARLES SCHUCHERT AND G. ARTHUR COOPER. Brachiopod Genera of the Suborders Orthoidea and Pentameroidea. Memoirs of the Peabody Museum of Natural History, Vol. IV, Pt. 1, 1932, New Haven, Connecticut.

This work by Drs. Schuchert and Cooper is an outstanding contribution to the literature on the Brachiopoda. It is in the class of Hall and Clarke's great work on this group, the Memoir on the brachiopods of the Cambrian by Walcott, and the works of Davidson on the brachiopods of the various geological systems, but it is superior to any one of these. It consists of six parts: Introduction (5 pages), Definition of brachiopod terms (6 pages), Principles of morphogenesis or evolution of form (6 pages), Morphology of the orthoid shell (25 pages), Genera of the suborder Orthoidea (111 pages), Genera of the suborder Pentameroidea (45 pages), and a brief Appendix in which are considered two genera formerly referred to the Pentameroidea but now doubtfully assigned to the superfamily Rhynchonellacea.

The memoir contains twenty-nine plates on which are bountifully illustrated the genera that have been differentiated. The illustrations on these plates are mostly new, are well chosen, and the work has been nicely done. In addition, numerous text figures are found throughout the book.

The morphology of the orthoid shell is considered in detail under the four captions of the morphology of the exterior, the ventral interior, the dorsal interior, and the microstructure of the shell. The writer knows of no other place where information on shell morphology is so complete and is given in such compact form as here.

The suborder Orthoidea is divided into the superfamily of Orthacea with eleven families and fifty-three genera and subgenera of which three, *Porambonites*, *Noetlingia*, and *Lycophoria*, were formerly assigned to the Pentameroidea; the superfamily Clitambonacea (formerly assigned to the Pentameroidea with two families and thirteen genera; and the superfamily Dalmanellacea with nine families and thirty-seven genera and subgenera. The reader will be interested to find that the Devonian genus *Tropidoleptus*, previously assigned to the Strophomenacea, is placed in the Dalmanellacea. There are six new families erected for the Orthacea, one for the Clitambonacea, and six for the Dalmanellacea; a total of thirteen new families. Twenty-nine new genera are proposed for the Orthoidea as a whole, the number of new genera having been expanded from the fifty-two listed in 1929 by Schuchert and LeVene to the 103 given in this work.

Part V treats of the Pentameroidea and this suborder is considered in the same manner as the suborder Orthoidea except that consideration of the morphological and the other characters is closely associated with discussion of the genera. The suborder is divided into two superfamilies, the Syntrophiacea with three families of which two are new, and eight genera, an expansion from the six previously known; and the Pentameracea with three families divided into twenty-four genera and subgenera of which four are new. There is a total of thirty-two genera, of which twenty-six were listed in 1929 by Schuchert and LeVene.

In the descriptions of the genera a very definite system is followed. This leads to brevity of statement and makes for ease on the part of the reader in finding the facts with respect to any genus.

The reviewer wishes to congratulate the authors on the completion of this memoir and to express the hope that they may find themselves in position to continue their studies upon the Brachiopoda and thus make available to students additional memoirs of merit equal to that here considered.

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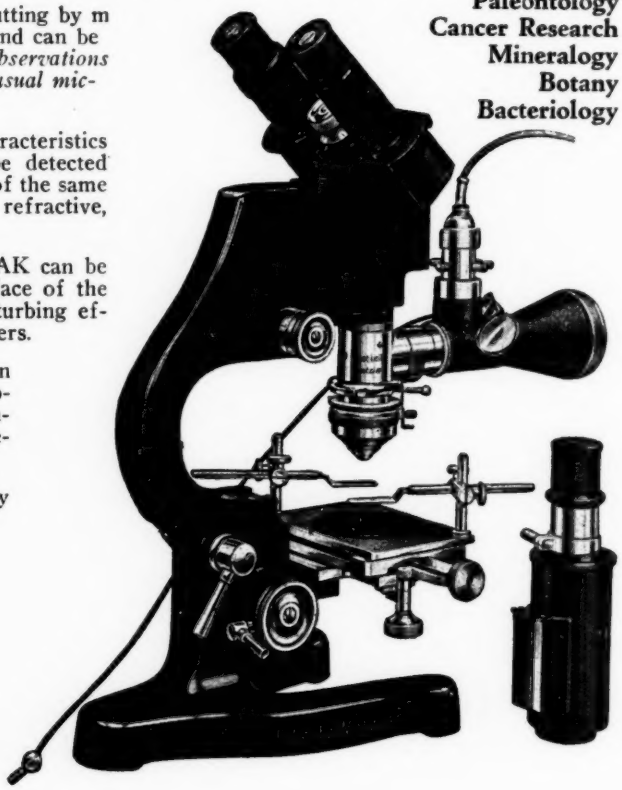

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